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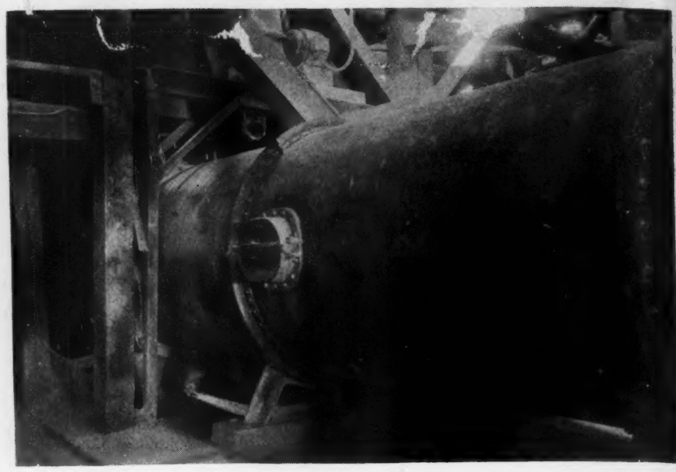
Lime Production in New Brunswick, Canada

SAINT JOHN, New Brunswick, is rich in deposits of both high calcium limestone and dolomite and supplies almost the entire demand of the Maritime Provinces. All of the quarries are in the belt of Pre Cambrian limestones and dolomites extending from Green Head on the Saint John river to Torryburn on the Kennebecasis river.

The ruins of many old lime kilns, including the old style square or pot kilns perched on the hillsides and along the banks of the Saint John river near Saint John, testify to the importance of this industry half a century or more ago. The framing of the McKinley tariff bill of 1890, in which a heavy duty was imposed on lime shipped into the United States, resulted in the closing of a great number of these kilns and others have since ceased operations for various reasons. In 1913 only six quarries were being operated. Today there are only three companies engaged in the manufacture of lime, operating six shaft kilns.

Of these, Snowflake Lime, Ltd., operates

Airplane view of the quarry, crushing plant and the lime kilns of Snow Flake Lime, Ltd., St. John, New Brunswick, Canada

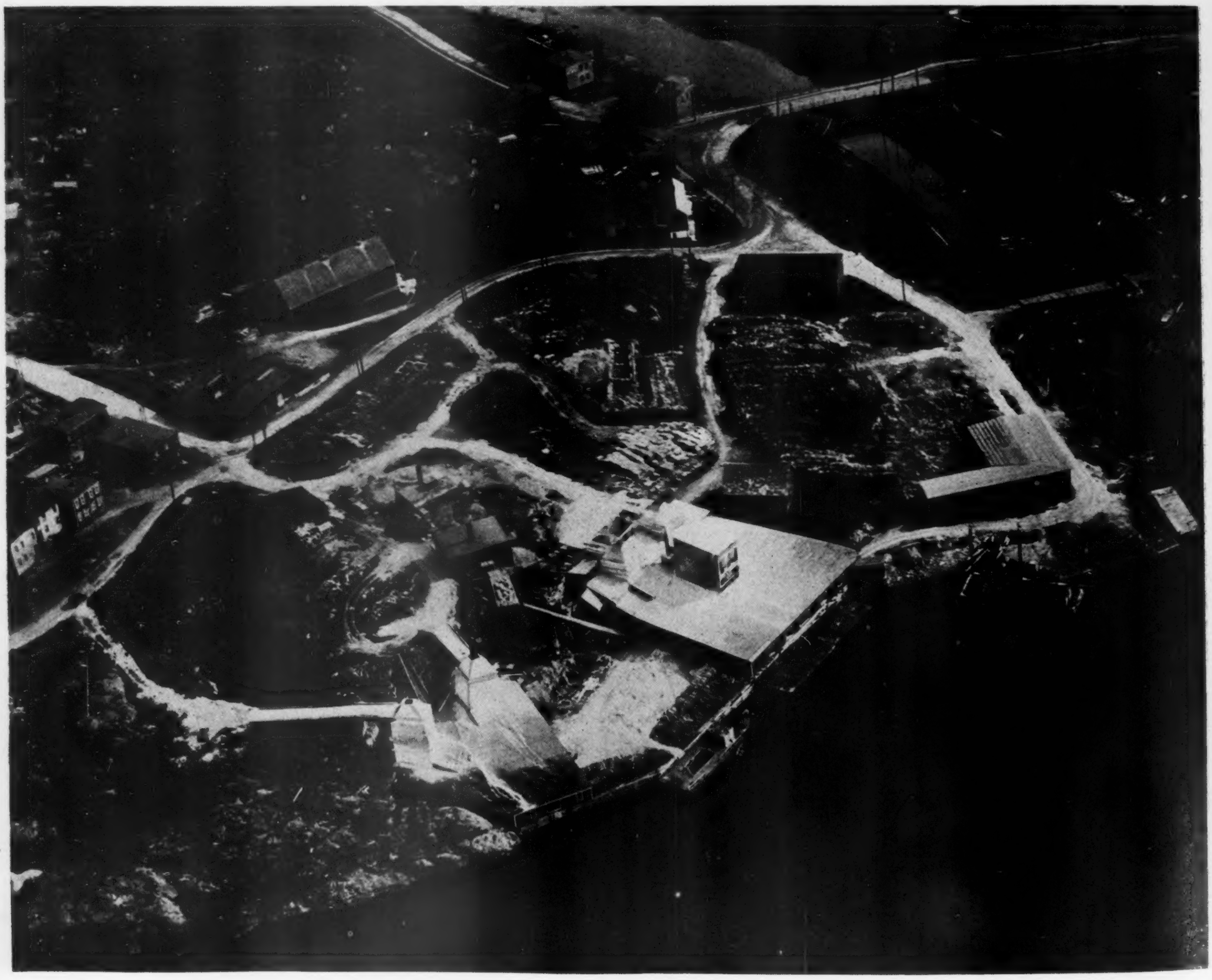


Hydrating plant and kilns, at left, and continuous hydrator at right

four kilns, with three running practically throughout the year. The lime is marketed under the brand of "Snowflake," first put on the market by Stetson, Cutler and Co. in 1885 and continued by them until 1928. Then Restigouche Co., Ltd., operated for a year and sold out to the present owners, Snowflake Lime, Ltd.

One or two new companies have entered the field, and in one case two steel-shell, coal-burning kilns were erected but did not survive; and, generally speaking, the methods of 50 years ago, such as drilling with steam, burning with wood and the use of horses in hauling, are still used, while the stone shaft draw kilns still prevail.

Late in 1928, after the organization of Snowflake Lime, Ltd., installation of a Schulthess hydrating plant was begun by that company and put into operation in January, 1929, when hydrated lime was manufactured in New Brunswick for the first time. At the same time the company replaced steam drills with compressed air and all horses were



Waterfront lime kiln and hydrating plant of Snow Flake Lime, Ltd.

Two views of the quarryng operations of Snow Flake Lime, Ltd.

supplanted by a small fleet of trucks.

Saint John limestone analyzes approximately 98% pure calcium carbonate, while the dolomite contains 40 to 45% magnesium carbonate. There is very little overburden. The rock is hand sledged to kiln size, loaded by hand to insure careful selection of best quality stone and trucked to the kilns. In all cases the kilns are so located that trucks dump directly into them at the top. Some of the kilns are built of granite, others of limestone, with either steel or concrete domes, and lined with firebrick. They are approximately 20 ft. square outside and from 30 to 40 ft. high. The lime is drawn at intervals of 6 to 8 hr., depending on whether three or four draws are made per day. The output of each kiln is 8 to 10 tons per day. The lime is cooled, then carefully selected and put up in wooden casks or barrels weighing respectively 400 and 200 lb., in which manner it is marketed. These containers are made at the plant.

Wood Used for Burning Lime

Soft wood is used for firing, each kiln requiring about five cords every 24 hr. In the past this wood was cut along the river during the winter months and freighted to the kilns the following summer, but of late the greater part of the wood used is trucked directly to the kilns daily as required, so that it is not necessary now to carry some four months stock of wood on hand to supply the kilns during the winter. Hydrated lime is put up in Bates multi-wall paper bags.

The company gives year round employment to some 40 men, the majority of whom have had from 25 to 40 years experience. Some 7000 cords of wood are used annually and the four kilns and hydrate plant have a capacity of about 15,000 tons per year, with about 10,000 tons being this year's output. The company recently put into operation a crushed stone plant where quarry spalls will be utilized to make pulverized limestone both high calcium and dolomite, for agricultural purposes.

Train of Dynamite Explodes

WHAT HAPPENS when a train with 33 cars of explosives, 312 tons in all, explodes was demonstrated at Leeuwdoornsstad, in southwestern Transvaal, South Africa recently. ROCK PRODUCTS is indebted to G. B. Gordon, director, National Lime and Stone Corp., Ltd., Johannesburg, for a report of the tragedy.

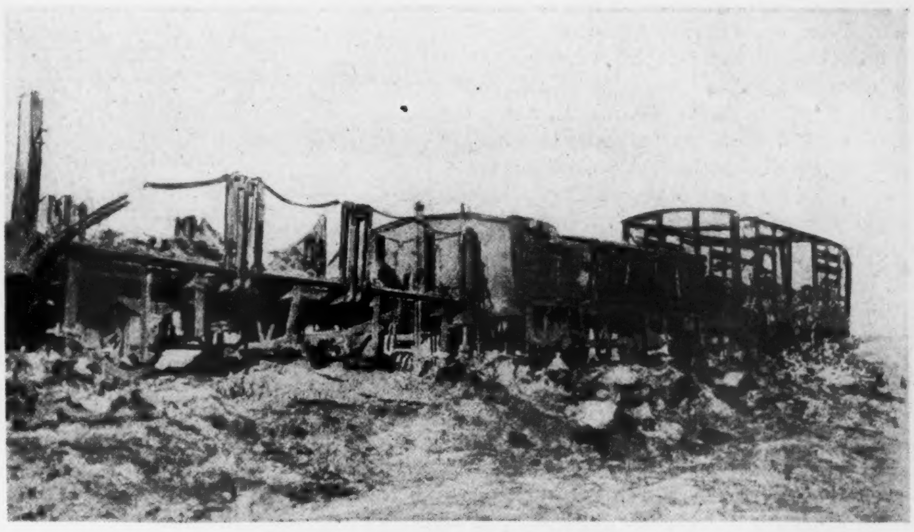
Dynamite is regularly transported by train into the above district, a distance of almost 1000 mi. These trains run under special observation, but, as the explosion demonstrated, the very greatest of care must always be maintained, especially when dealing with explosives.

The accident was attributed to a broken axle on one of the cars, possibly the result of a hot box. Five miles from the accident sparks were seen flying from one of the trucks of one of the dynamite cars. Efforts to warn the train crew were unsuccessful. The axle broke about two miles from the explosion.

According to the engineer his first intimation of disaster was when the fireman told him to look at the smoke and dust coming from under the train. He immediately brought the train to a stop. Before he could get out to investigate the explosion occurred.

A special car for a guard was carried at the rear of the train. This car was demolished and the guard killed. There were a number of cars of farm products between the explosives and the locomotive. This is believed to have saved the engine crew from the same fate as the guard. While stunned, neither was seriously injured.

In addition to the guard on the train, four residents in the near vicinity were killed and several injured, being caught in the wreckage of buildings in which they were at the time. Many buildings in the immediate vicinity were demolished. The explosion was felt for more than 158 mi., and the section of the tracks at which the explosion took place was said to resemble a trench that had been heavily bombarded. Wreckage was hurled for seven miles. This is said to be the third disaster of its kind in the history of gold mining.



About all that was left of the train

Gold as Sand and Gravel By-Product

By Edmund Shaw
Contributing Editor, Rock Products

"MINING IN CALIFORNIA," a quarterly published by The State Division of Mines, Ferry Bldg., San Francisco, Calif., devotes the whole of its April number to placer mining, as the recovery of gold from sand and gravel is called. A great many gold saving methods and devices, some of them the product of the present depression, are described—most of them for working dry sands. Interest in gold mining of any kind is great, now that a gold dollar will buy twice or more than twice as much in commodities as it bought before 1929. And the man who would not cross the road to look at a placer that would yield a dollar a day now is willing to walk miles and suffer considerable hardship to work such a place. In California, the state, counties and cities are encouraging the operation of small placers on public lands and even furnishing instructors for the amateur miners.

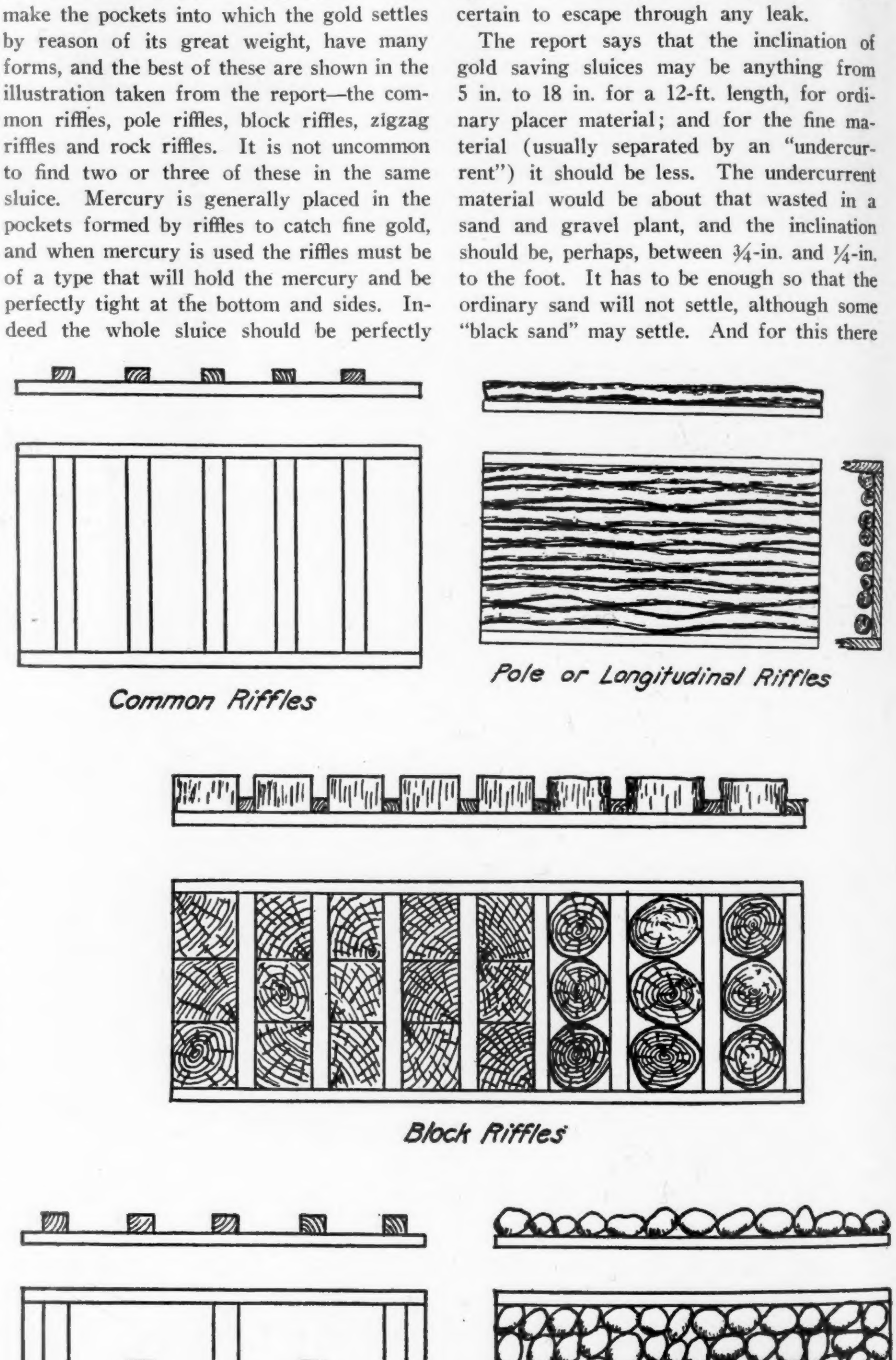
It is also encouraging operators of sand and gravel plants to look for gold in their plant wastes. In Fresno county, it is reported, there are several sand and gravel operators recovering gold either experimentally or in a commercial way, the Grant Rock and Gravel Co., of Fresno, being reported as especially successful. In other parts of the state operators are sampling wastes and studying methods to see if they can add a few cents in gold to the value of each ton of salable aggregates.

But the by-product gold possibilities of commercial sand and gravel operations are by no means confined to California, for Washington, Oregon, Colorado, Montana, Idaho, Utah, Nevada, Wyoming, South Dakota, Arizona and New Mexico all have had placer mining industries in the past, and some small working of placers has been carried on even during the boom period. Within comparatively recent years placers have been worked in Georgia and North and South Carolina. Even the middle western states and the New England states have records of glacial deposits that yielded enough gold to pay for small scale working. So it would seem wise for the sand and gravel operator in almost any part of the United States to take the little trouble that is required to sample his plant wastes and test them for gold.

Simple Methods of Sampling for Gold

The added equipment required to save gold from sand and gravel wastes is simple and inexpensive. To turn the sluice that runs the fine sand and silt to waste into a gold saving sluice one has only to add riffles and give the riffle sluice or flume the proper width and inclination. These riffles, which make the pockets into which the gold settles by reason of its great weight, have many forms, and the best of these are shown in the illustration taken from the report—the common riffles, pole riffles, block riffles, zigzag riffles and rock riffles. It is not uncommon to find two or three of these in the same sluice. Mercury is generally placed in the pockets formed by riffles to catch fine gold, and when mercury is used the riffles must be of a type that will hold the mercury and be perfectly tight at the bottom and sides. Indeed the whole sluice should be perfectly tight, as the fine gold and mercury will be certain to escape through any leak.

The report says that the inclination of gold saving sluices may be anything from 5 in. to 18 in. for a 12-ft. length, for ordinary placer material; and for the fine material (usually separated by an "undercurrent") it should be less. The undercurrent material would be about that wasted in a sand and gravel plant, and the inclination should be, perhaps, between ¾-in. and ¼-in. to the foot. It has to be enough so that the ordinary sand will not settle, although some "black sand" may settle. And for this there



Riffles used in saving gold from sand and gravel wastes

must be some "boil" in the riffles. The experimenter may try the sluice with filings of gold or even of lead to satisfy himself that the riffles will really catch gold.

It is common to use flakes of gold or small shot in learning to use a gold pan, and it is needful to learn this to test the plant wastes. The California report gives excellent directions for panning, which are abstracted briefly here:

A small frying pan (with slanting sides) that contains no grease will do for the novice, and he should have a sample of about 2 lb. of coarse and fine sand with a few flakes of gold or some heavy mineral. The pan, about three-fourths full, is submerged in a tub of water and stirred with the fingers. Then it should be given a rotating movement tipping it slightly from side to side. Then it should be given short jerky shakes from side to side to send the heavy mineral to the bottom. Then it should be slowly sunk in the water while it is being rotated slowly to wash off the top material, and this rotating and shaking and washing off should be repeated until only about a teaspoonful of material is left. This is collected in the joint between the bottom and the side of the pan and "tailed out" by washing a little water over it, by swinging the pan. The gold will be found to drag behind all the other minerals.

Not only gold but silver, tungsten, quicksilver and platinum and other valuable minerals are found by panning. The value of *any* heavy mineral found by panning should be determined by a competent chemist. Even black sand may have a very high gold value.

Every good library has books on mining which will describe placer mining methods. The quarterly mentioned is sold by the California State Division of Mines for 25 cents.

Middle West Farmers Using More Phosphates

WITH SUGAR-BEET GROWERS pointing the way, more and more fertilizers, chiefly phosphates, are being used in the Middle West for sugar beets, grains, alfalfa and other crops, says the United States Department of Agriculture.

Although they doubted that the rich soils of the sugar-beet regions required fertilizers, the growers found their yields decreasing, and asked the department for fertilizer information on the soils. Experiments in which different combinations of phosphates, nitrates and potash were used showed the chief fertilizer need was for phosphates.

At Grand Island, Neb., tests showed that 500 lb. of 16% superphosphate per acre gave 16.8 tons of beets where unfertilized plots yielded only 4.9 tons an acre. In general it was found that $2 or $3 an acre spent for fertilizer increased the value of the yield about $15.

The need for phosphates is fairly general in the Middle West. Even in the rich Red River Valley of North Dakota and Minnesota, where sugar-beet growing is relatively new, the farmers found that fertilizers paid.

The increased use of fertilizers by the sugar-beet growers has led to their use for other crops, the department says. It estimates that the value of the 1931 sugar-beet crop was increased $5,000,000 with $700,000 worth of fertilizers, and that the need of fertilizers for other crops in the Middle West is very large.

Asphalt Demand and Production Lower in 1931

DECREASED DEMAND, domestic and foreign, for petroleum asphalt, and increased imports of lake asphalt and grahamite reduced the 1931 output of petroleum asphalt at United States refineries 248,198 short tons in comparison with 1930, and during 1931 added 16,732 tons to stocks held at refineries. Production of asphalt (exclusive of road oil) at petroleum refineries in the United States amounted to 2,975,690 short tons in 1931, compared with 3,223,888* tons in 1930 and 3,830,457* tons in 1929, according to figures compiled by the Bureau of Mines, Department of Commerce.

*Revised figures.

Feldspar and Quartz in 1931

STATISTICS on the feldspar and quartz industry in Canada in 1931 have been issued by the Dominion Bureau of Statistics. This includes information on capital, employment, fuel, electricity, etc., in addition to production and consumption data.

Canadian Asbestos in 1931

"THE Canadian asbestos mining industry continued to feel keenly in 1931 the effects of the world-wide depression to which was added the increasing competition of Russian and Rhodesian fibre," states the report of the Dominion Bureau of Statistics in its report of the industry, recently issued. The report gives a detailed review of the industry and its operation in Canada with statistics on both domestic and foreign production.

Mineral Production of the United States in 1931

IN 1931 the approximate total value of nonmetallic mineral products in the United States was $719,700,000. The total value of nonmetallic mineral products in 1931 decreased 31% from the preceding year, the Bureau of Mines reports in an advance report on the mineral industries.

This statistical analysis of the quantity and value of mineral products for the year 1931 summarizes the principal results obtained from the annual canvass of the mineral industries. Pending completion of the more comprehensive commodity surveys, it presents in condensed form—as early as possible—the statistics of output and value. This report is subject only to minor revisions of statistics as may be required by receipt of additional data on the annual canvasses after the preparation of this study.

Details for individual minerals, in so far as they are available at present, are shown in the following table:

NONMETALLIC MINERAL PRODUCTS OF THE UNITED STATES, 1930 AND 1931 (1)

Product	Unit	1930 Quantity	1930 Value	1931 Quantity	1931 Value
Asbestos	short tons	4,242	289,284	3,228	118,967
Barite (crude)	short tons	234,932	1,538,171	174,520	994,655
Borates (colemanite and naturally occurring sodium borates)	short tons	177,360	5,351,999	172,600	4,761,295
Bromine	lb.	8,462,800	2,109,974	8,935,330	1,854,650
Calcium-magnesium chloride	short tons	116,160	2,207,800	86,156	1,687,166
Cement	bbl.	160,846,350	231,249,287	128,325,382	142,528,789
Diatomite and tripoli (13)	short tons	32,439	507,505	26,682	310,131
Emery	short tons	555	5,996	512	5,557
Feldspar (crude)	long tons	171,788	1,066,636	147,119	861,059
Fluorspar	short tons	95,849	1,746,643	53,484	931,275
Fuller's earth	short tons	335,644	4,326,705	288,400	3,055,570
Garnet for abrasive purposes	short tons	5,003	314,129	2,946	193,015
Graphite:					
Amorphous	short tons	1,941	20,525	(9)	(9)
Crystalline	lb.	(15)	(15)	(9)	(9)
Gypsum	short tons	3,471,393	27,051,484	2,559,017	20,801,357
Lime	short tons	3,387,880	25,616,486	2,710,000	18,506,000
Magnesite (crude)	short tons	129,320	1,033,130	73,602	499,239
Mica:					
Scrap	short tons	6,732	109,100	6,621	99,415
Sheet	lb.	1,465,485	177,307	962,953	111,830
Phosphate rock	long tons	3,926,392	13,996,830	2,534,959	9,288,485
Pumice	short tons	56,843	336,099	68,819	338,586
Sand:					
Glasss	short tons	1,849,101	3,210,973	1,600,000	2,600,000
Molding, building, etc., and gravel	short tons	195,202,625	111,965,570	153,400,000	85,400,000
Sand-lime brick (19)	thousands	191,193	1,950,709	146,514	1,269,405
Silica (quartz)	short tons	13,156	121,289	7,851	69,103
Slate	short tons	463,610	7,911,618	368,420	5,498,336
Stone	short tons	126,996,340	178,948,611	96,200,000	131,248,000
Talc and soapstone (20)	short tons	179,385	2,108,338	163,752	1,852,472
			1930 value		1931 value
Total value of nometallic products (exclusive of mineral fuels)			1,008,900,000		719,700,000

(1) In this general statement certain of the figures represent shipments rather than quantity mined, and some of the figures for 1931 are estimates.

(9) Figures for 1931 are not available.

(13) Figures represent tripoli only. Value of diatomite is included in total value of nonmetallic products; Bureau of Mines not at liberty to publish figures.

(15) Value included in total value of nonmetallic products; Bureau of Mines not at liberty to publish figures.

(19) According to Bureau of the Census.

(20) Figures represent talc only. Value of soapstone is included in total value of nonmetallic products; Bureau of Mines not at liberty to publish figures.

Rate of Stiffening of Mortars on a Porous Base*

By L. A. Palmer[1] and D. A. Parsons[1]

Abstract

THE rates of stiffening of 50 different mortars on a porous base have been studied. Four limes, 12 masonry cements and two portland cements were included in the study. The data from "flow" curves and from the water losses of the mortars during different "suction times" on the porous base are combined to give flow versus time relationships. Some mortars which differed widely in composition had nearly the same derived rate of stiffening on the basis of water loss. Substitution of lime for portland cement tended to decrease the rate of stiffening under these conditions. Mortars made with natural cements containing water-repellent substances stiffened more slowly than other masonry cement mortars.—The Author.

THE MOST SUITABLE combinations of masonry building units and mortars from the standpoint of resistance to the transmission of moisture is a subject that is being given much consideration. It is likely that among other things, the rate of water absorption of the unit and the resistance of the mortar to loss of water to the unit are important considerations. All other things being equal, the more quickly a mortar loses water to a porous building unit, the more rapid is its rate of stiffening. If the stiffening is too rapid, the mason has difficulty in getting good contact between units and mortar. If it is too slow, as sometimes happens when an impervious unit is used with a slow hardening mortar, there is apt to be slipping of bricks out of plumb.

It may be more practical to adapt the mortar to the unit rather than vice versa. With units of "high suction" it should be possible to select mortars that either have high resistance to loss of water by suction or else which stiffen relatively less than other mortars with a given amount of water loss.

Previous investigations (Emley,[2] Palmer and Hall,[3] Bates and Rogers,[4] Bates and Dwyer,[5] and Pearson[6]) have indicated to some degree the effect of the rate of loss of water of a mortar on such physical properties as plasticity or workability and have studied methods of correlating the rate of water loss with these properties.

The rate of stiffening of mortars on a porous base is one phase of an investigation at the Bureau of Standards that is being sponsored by the American Face Brick Association, the National Lime Association, and a group of masonry cement producers. In view of the fact that practically all masonry units tend to withdraw water from mortar, it was planned to study the "water retaining capacities" of the 50 mortar compositions included in the general investigation.

Twelve masonry cements, two portland cements and four limes were used as cementing materials. These were representative of products of manufacturers in various parts of the United States. The twelve masonry cements are numbered from 1 to 13, these numbers corresponding with those already given other shipments (from the same manufacturer) by co-workers at the Bureau of Standards who are using these and a number of other masonry cements in an extensive study. Fairly clean Potomac river sand that had passed a No. 8 sieve was used in all mortars. The sieve analysis of the Potomac river sand was approximately that given on page 475 of Bureau of Standards Research Paper No. 290.

Proportioning

In Table I are given the designations of the 50 mortars studied. It is noted that with the exception of the eight portland cement-lime mixtures of volume proportions 1P.C.:0.15L:3Sand, the proportions are on the basis of one bulk volume of total cementing materials to three of sand.

The weights per cubic foot of the various cementing materials and of the sand were obtained prior to making the tests to be described. A 1/3 cu. ft. container was used for determining the weight per cubic foot of the dry cementing materials. A 1/10 cu. ft. container was used in the case of sand and freshly slaked lime putties. In obtaining the weight per cubic foot, all except the lime putties were tamped with a rod in the manner described in Standard Method of Test for Unit Weight of Aggregate for Concrete, Serial Designation C29-27, A. S. T. M. Standards, page 151, Part II, 1930. It is seen in Table I that the weight of 3 cu. ft. of the dry sand was 5.18 times the weight of 1 cu. ft. of masonry cement No. 11. Accordingly in preparing a mortar with this cement, the weight of sand used was 5.18 times that of this cement in any test. Similar procedures were used with the other mortars.

With a lime putty the volume basis of proportioning was the putty itself. These were mixed to a good workable consistency and contained 50% to 55% of water in addition to the hydrated lime formed by slaking. The amount of water in excess of that required for hydration was determined by drying 100-g. samples of the putty in an electric oven for 24 hours at 100 to 115 deg. C. The computed amounts of hydrated lime rather than the weights per cubic foot of these putties are recorded in the fifth column of Table I for the purpose of comparing these mortars with others made with limes Nos. 2 and 3 already slaked when received.

The amount of water added in any case was computed on the basis of per cent of total weight of dry materials. Two procedures were followed when the mortar contained only hydrated lime (mortars C II or C III) and sand. In one case, a weighed amount of the dry hydrated lime was well mixed with water of known quantity and sufficient to form a thick paste and this was left undisturbed for 24 hours prior to using it in tests. The other procedure was to use the dry hydrate without preliminary soaking. In the study of all mortar compositions containing either lime No. 2 or 3 together with a portland cement, the lime was soaked for 24 hours prior to mixing it with the cement and sand and making tests.

Limes Nos. 1 and 4 (quicklimes) were slaked for a period of one week before use. The amount of free water present was determined daily subsequent to this period of slaking.

Use of the Flow Table

The flow table and its use is described in Federal Specification for Cement; Masonry, SS-C-181, January 6, 1931 (see F-3g (3) a. Apparatus.) The "flow" is determined by measuring the increase in diameter of a mass of mortar after removing a mold containing it on a flat, circular top of a table and dropping the table top through a height of ½ in. 25 times in 15 seconds.

A "flow" curve was obtained with each of

*Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce.

[1] Research Associate. Mortars and Masonry Research Fellowship at U. S. Bureau of Standards, Washington, D. C.

[2] Warren E. Emley. B. S. Tech. Paper No. 169, Measurement of Plasticity of Mortars and Plasters.

[3] L. A. Palmer and J. V. Hall. Durability and Strength of Bond between Mortar and Bricks, B. S. Research Paper No. 290.

[4] P. H. Bates and J. S. Rogers, Unpublished data.

[5] P. H. Bates and J. R. Dwyer, Cement as a Factor in the Workability of Concrete, Proc. Am. Concrete Institute, **24**, 43-45 (1928).

[6] J. C. Pearson. Properties and Problems of Masonry Cements, Proc. Am. Concrete Institute, **28**, 349-361 (1932).

the 50 mortar compositions by plotting the measured flow against the amount of water (in terms of per cent of weight of total dry materials) required to produce it. At a certain lower limit, characteristic of the materials, the amount of water used, instead of producing a "flow," resulted only in a crumbling of the mortar. When this occurred, the spread was not considered as flow and hence is not plotted. All flow table determinations were made in a constant temperature room wherein the temperature was 70 ± 1 deg. F. All mortars were mixed for two minutes as it was found that they could be well mixed in this time. Most of the deviations among the flow table data obtained were found to be directly traceable to small variations in the sand. Such variations are to be expected in most building sands.

Use of the Suction Apparatus

The loss of water by suction was determined with the Rogers device, illustrated in Fig. 1. The cup, having a perforated base, was filled with mortar of wet consistency (flow of 130%). The depth of mortar in the cup after levelling with a spatula was ½ in. Thus an approximately constant volume of mortar was used in all tests. Care was taken to avoid patting or tamping the mortar. A rubber gasket, fitted between the rim of the cup and funnel, prevented infiltration of air through any source other than the mortar itself. A filter paper covering the bottom of the cup prevented loss of solid material through the perforations and also served to prevent their becoming clogged. With the stopcock open, a suction equivalent to 2 in. of mercury was applied to the flask. This degree of suction was found by Rogers to be about equivalent to that of a dry dry-press brick, a type of building unit that is used extensively. All tests were made in the constant temperature room.

Starting with a given volume and weight of mortar (of 130% flow) containing a

TABLE I. MORTARS STUDIED

Mortar designation	Cementing materials used	Description of cementing materials	Proportions by bulk volume with sand	Proportions by weight with sand
A I	Portland cement No. 1	Gray, typical portland	1P.C.:3S	1P.C.:3.44S
A II	Portland cement No. 2	White	do.	1P.C.:3.49S
B I	Masonry cement No. 1*	Modified natural cement	1M.C.:3S	1M.C.:4.62S
B II	Masonry cement No. 2	Slag and portland cement	do.	1M.C.:4.36S
B III	Masonry cement No. 3	Natural cement	do.	1M.C.:6.14S
B IV	Masonry cement No. 4	Slag and hydrated lime	do.	1M.C.:4.48S
B V	Masonry cement No. 5	Mixture of hydrated lime and portland cement	do.	1M.C.:6.27S
B VI	Masonry cement No. 6*	Modified natural cement	do.	1M.C.:5.09S
B VII	Masonry cement No. 7*	Modified natural cement	do.	1M.C.:4.57S
B VIII	Masonry cement No. 8*	Modified portland cement	do.	1M.C.:5.24S
B X	Masonry cement No. 10*	Modified portland cement	do.	1M.C.:4.20S
B XI	Masonry cement No. 11*	Modified natural cement	do.	1M.C.:5.18S
B XII	Masonry cement No. 12	Natural cement	do.	1M.C.:4.85S
B XIII	Masonry cement No. 13*	Modified natural cement	1M.C.:3S	1M.C.:4.76S
C I	Lime No. 1	High calcium quicklime	1L:3S	1 dry hydrate**:8.12S
C II	Lime No. 2	Dolomitic hydrated lime	do.	1L.:10.52S
C III	Lime No. 3	High calcium hydrated lime	do.	1L:9.21S
C IV	Lime No. 4	Dolomitic quicklime	do.	1 dry hydrate**:7:26S
XRa	Portland cement No. 1 and lime No. 1	....	1P.C.:1L:6S	1P.C.:0.42 dry hydrate**:6.88S
XRb	do.	....	1P.C.:2L:9S	1P.C.:0.85 dry hydrate**:10.31S
XRc	do.	....	1P.C.:3L:12S	1P.C.:1.27 dry hydrate**:13.75S
XRd	do.	....	1P.C.:0.15L:3S	1P.C.:0.06 dry hydrate**:3.44S
XSa	Portland cement No. 1 and lime No. 2	....	1P.C.:1L:6S	1P.C.:0.33L:6.88S
XSb	do.	....	1P.C.:2L:9S	1P.C.:0.65L:10.31S
XSc	do.	....	1P.C.:3L:12S	1P.C.:0.98L:13.75S
XSd	do.	....	1P.C.:0.15L:3S	1P.C.:0.05L:3.44S
XTa	Portland cement No. 1 and lime No. 3	....	1P.C.:1L:6S	1P.C.:0.37L:6.88S
XTb	do.	....	1P.C.:2L:9S	1P.C.:0.75L:10.31S
XTc	do.	....	1P.C.:3L:12S	1P.C.:1.12L:13.75S
XTd	do.	....	1P.C.:0.15L:3S	1P.C.:0.06L:3.44S
XVa	Portland cement No. 1 and lime No. 4	....	1P.C.:1L:6S	1P.C.:0.47 dry hydrate**:6.88S
XVb	do.	....	1P.C.:2L:9S	1P.C.:0.95 dry hydrate**:10.31S
XVc	do.	....	1P.C.:3L·12S	1P.C.:1.42 dry hydrate**:13.75S
XVd	do.	....	1P.C.:0.15L:3S	1P.C.:0.07 dry hydrate**:3.44S
YRa	Portland cement No. 2 and lime No. 1	....	1P.C.:1L:6S	1P.C.:0.43 dry hydrate**:6.97S
YRb	do.	....	1P.C.:2L:9S	1P.C.:0.86 dry hydrate**:10.46S
YRc	do.	....	1P.C.:3L:12S	1P.C.:1.29 dry hydrate**:13.95S
YRd	do.	....	1P.C.:0.15L:3S	1P.C.:0.06 dry hydrate**:3.49S
YSa	Portland cement No. 2 and lime No. 2	....	1P.C.:1L:6S	1P.C.:0.33L:6.97S
YSb	do.	....	1P.C.:2L:9S	1P.C.:0.66L:10.46S
YSc	do.	....	1P.C.:3L:12S	1P.C.:0.99L:13.95S
YSd	do.	....	1P.C.:0.15L:3S	1P.C.:0.05L:3.49S
YTa	Portland cement No. 2 and lime No. 3	....	1P.C.:1L:6S	1P.C.:0.38L:6.97S
YTb	do.	....	1P.C.:2L:9S	1P.C.:0.76L:10.46S
YTc	do.	....	1P.C.:3L:12S	1P.C.:1.14L:13.95S
YTd	do.	....	1P.C.:0.15L:3S	1P.C.:0.06L:3.49S
YVa	Portland cement No. 2 and lime No. 4	....	1P.C.:1L:6S	1P.C.:0.48 dry hydrate**:6.97S
YVb	do.	....	1P.C.:2L:9S	1P.C.:0.96 dry hydrate**:10.46S
YVc	do.	....	1P.C.:3L:12S	1P.C.:1.44 dry hydrate**:13.95S
YVd	do.	....	1P.C.:0.15L:3S	1P.C.:0.07 dry hydrate**:3.49S

*Contained metallic stearates. **The amount of dry hydrate per unit weight of freshly slaked lime putty was obtained by drying small samples of the putty for 24 hours in an oven at about 115 deg. C.

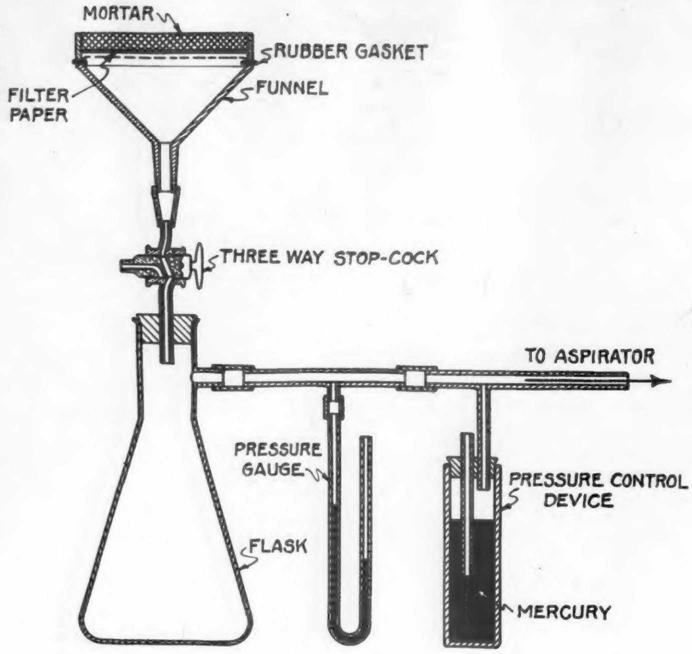


Fig. 1. Apparatus used in measuring the rates of water loss of mortars

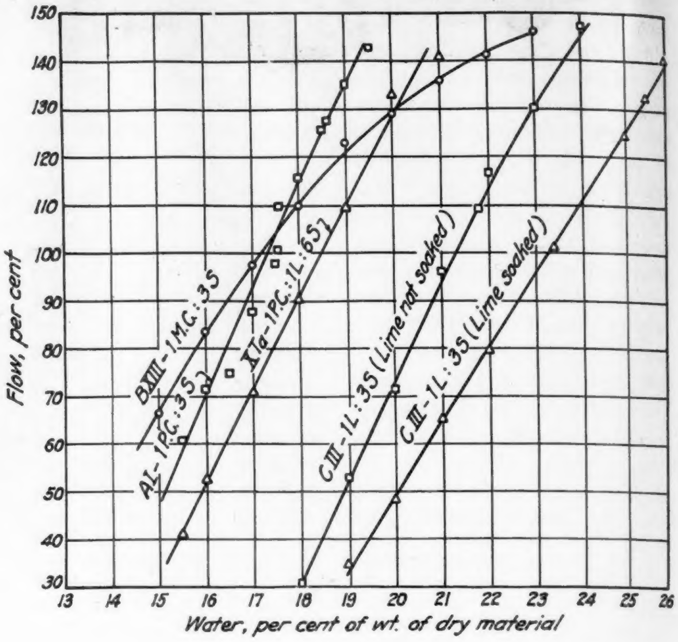


Fig. 2. Flow curves, representative of the 50 mortars studied

known weight of water, the amount of water lost by suction after any time could be measured by closing the stopcock, removing the cup and weighing. Such weighings were made at ½, 1, 2, 3, 4, 5, 6 and 7 minute intervals. This was taken to represent the suction of a "standard porous base."

Vicat Measurements

The Vicat method used is that described in Section IV, Part V, Federal Specification (revised) SS-C-191 for Cement; Portland.

After the mortar had been subjected to suction (interrupted by weighings) for a total time of 7 minutes, it was packed in the molds for the Vicat test. The depth of penetration in millimeters of the rod of one cm. diameter during 30 seconds was recorded.

Flow Table and Suction Data

The data of the flow curves illustrated in Fig. 2 may be combined with the data of the loss of water versus time curves illustrated in Fig. 3. These combined data are expressed graphically in Figs. 4, 5 and following, wherein per cent flow is plotted against suction time. A typical example will illustrate the method used. In Fig. 3 it is seen that a given volume and known weight of the mortar B XIII lost 13 g. of water during suction for one minute. In Fig. 2 it is seen that the flow of this mortar of 130% before applying suction was obtained by adding a quantity of water equal to 20% of the total weight of dry materials. The 13 g. of water lost during one minute under suction was known to be 3% of the total weight of dry materials. Reading off the curve for B XIII, Fig. 2, it is seen that 20% minus 3% or 17% of water corresponds to a flow of 98% with this mortar. Similarly the flow of B XIII is interpolated from the curves as being 82% after two minutes suction.

The flow versus time curves in Figs. 4, 5 and following, illustrate the comparative rates of stiffening of different mortars on the porous base and show that the workability of mortars on a porous base is a dynamic and not a static condition. The problem of getting a mortar of a suitable degree of workability is not solved by merely adding water until a desired consistency is attained. A certain degree of workability must be *retained* (as well as attained) over a brief period while the units are being placed.

In considering the flow versus time curves it is noted that the values plotted are in per cent of flow and units of time. The relative positions of these curves are, therefore, independent of any choice of units expressing the quantities of water added to and lost by the mortar in the flow table and suction tests. The amounts of water could have been expressed in terms of per cent. of weight of cement alone, per cent. of weight of all mortar materials including water or simply as grams. Cementing materials vary considerably with respect to bulk density as is seen in Table I. The curves of Fig. 3 would not diverge widely were the water loss there expressed as per cent of total weight of dry materials rather than as absolute units, i e., grams. Similarly by plotting grams of water rather than per cent the curves of Fig. 2 would diverge far less.

Typical flow curves for different mortars are given in Fig. 2, the curves showing representative types of the mortars studied. Were the flow curves of all others of the 50 mortar compositions plotted on this graph, practically all would fall *between* the curves for B XIII on the left and C III (lime soaked) on the right. Similarly the water loss versus time curves for mortars A II, B VIII, and B XIII in Fig. 3 represent the limit in range of conditions for all of the 50 mortar compositions. The curves for all

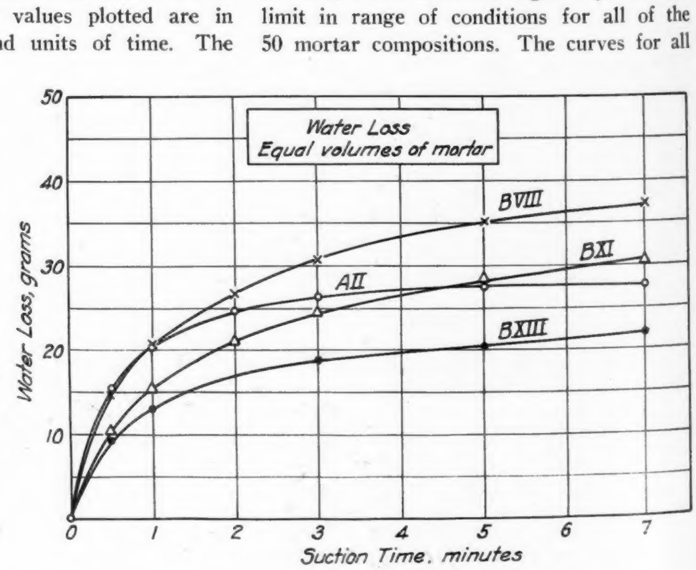


Fig. 3. Curves illustrating the comparative resistances of mortars to water loss by suction

of the other mortars would fall between these limits.

Check determinations of flow values with a given percentage of water with any of the mortars seldom varied more than 10%. A higher degree of variation must be always expected when ordinary building rather than a standard sand is used. It was possible to keep the deviations below 6% in most cases by carefully mixing the sand as it was taken from the bin.

Vicat Tests

Table II gives representative data on the derived flow and measured penetration of the Vicat plunger obtained with the 50 different mortars and covers the range of extreme and intermediate conditions, characteristic of these materials. The results obtained from the other mortars, omitted from Table II, would fall within the limits there expressed, were they also presented.

TABLE II. FLOW AND VICAT PENETRATION OF MORTARS
(Averages of three tests)

Mortar	Flow after suction for one minute Per cent.	Vicat peneration* after suction for seven minutes Millimeters
A I	45	0.3
A II	47	0.3
B III	41	0.5
YTb	54	0.5
XSb	55	0.3
XRd	56	1.3
B I	74	2.5
XRa	75	1.9
YTc	73	0.9
XVb	93	3.0
XVc	94	4.1
YVc	88	3.7
B XIII	96	7.5
C I	90	3.3

*The deviation ranged from zero to 70%. Highest deviation occurred when the penetrations were smallest.

The data of the second column of Table II are derived from flow curves, illustrated in Fig. 2 and from loss of water versus suction time curves, illustrated in Fig 3.

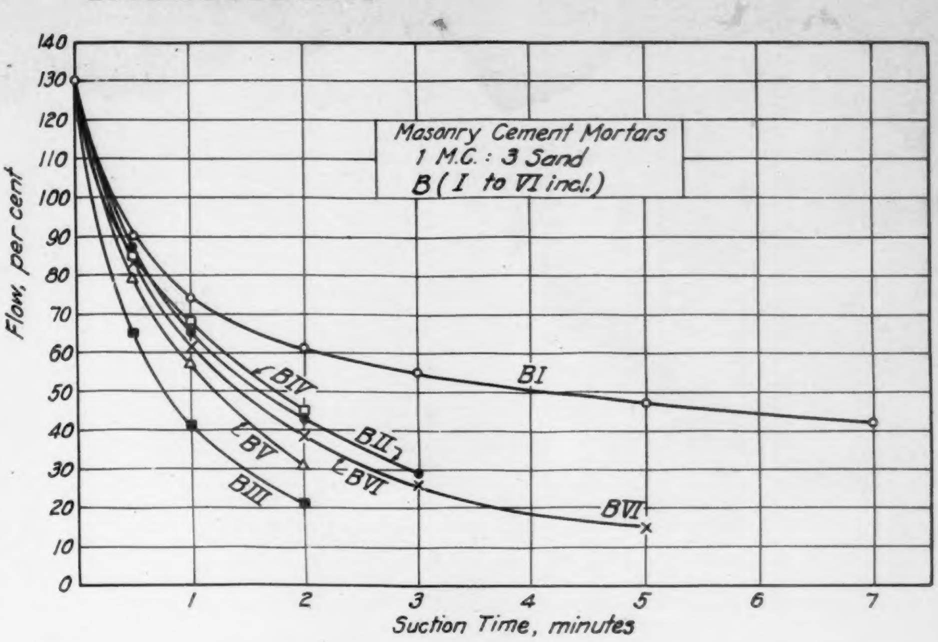


Fig. 4. Curves illustrating rates of stiffening of masonry cement mortars on a porous base

The flows after the intervals of suction were, therefore, not actually measured but were derived from the flow curves and on the basis of *water loss alone* and no variable factors other than water loss are considered in these derivations.

The values in the third column of Table II, on the other hand, were obtained by direct measurement with the mortars at the completion of suction. It is seen that no *good* correlation between the values of the second and third columns exists but that a high value for any mortar in the one column has a (usually) higher but not proportionately higher value in the other.

Fig. 2 also indicates that the average flow measurements there plotted do not extend down to as low values in some cases (mortars A I and B XIII) as in others (XTa and C III). There could be no derived flow value after suction had continued to a point which resulted in less residual water than that known to give the lowest plotted value in the flow curves (Fig. 2). This accounts for the fact that some of the curves of Figs. 4, 5, and following are not continued as far as others. This is also the reason for the values in Columns 2 and 3 of Table II being for different suction time intervals. The Vicat measurements (Column 3, Table II) were made after a suction interval of seven minutes and not earlier because of the fact that the plunger would penetrate entirely through some of the mortars after suction for periods of less than seven minutes.

The lower limits of the flow curves of Fig. 2 mark points below which it was found that the mortar crumbled and rolled and did not actually flow.

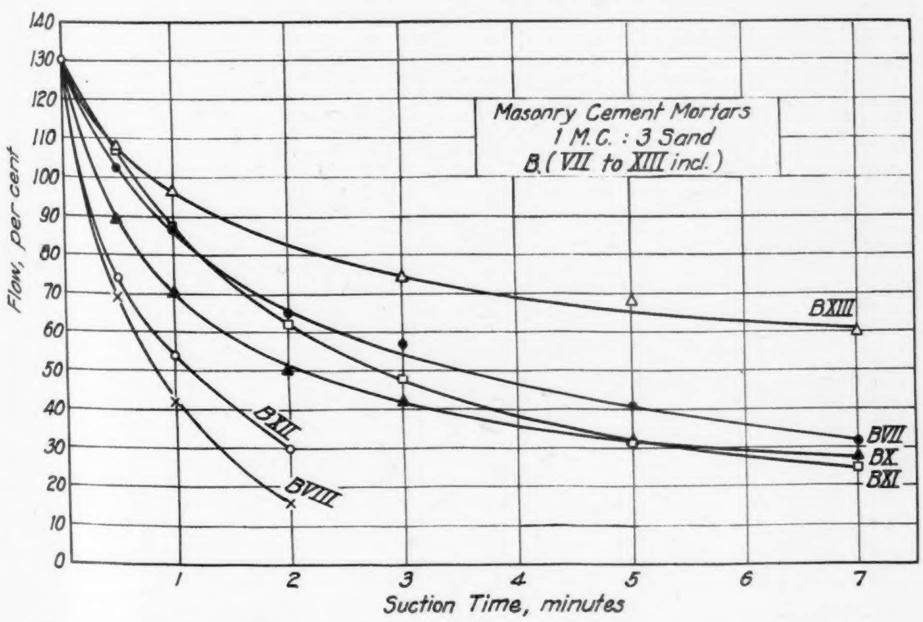


Fig. 5. Curves illustrating rates of stiffening of masonry cement mortars on a porous base

Masonry Cements

The flow-time relations for the masonry cement mortars are expressed in Figs. 4 and 5. With reference to Table I, mortars B I, B X, B VII, B VI, B VIII, B XI and B XIII contained metallic stearates. This material was added to the cements at the factories. The amounts of stearates added are not known. From Figs. 4 and 5 it is also noted that the natural cements B XIII and B I containing stearates had the lowest rates of stiffening on the porous base.

From the data of Table II and from the curves of Figs. 4, 5, 8, 9, 10, and 11 it is seen that the masonry cement mortars B I, B XI, B VII and B XIII compare favorably with lime mortars C I and C IV as well as with portland cement mixtures with these limes. This indicates that a certain mortar property may be obtained with markedly different mortar compositions.

Lime Mortars

In Fig. 6 are given the rates of stiffening

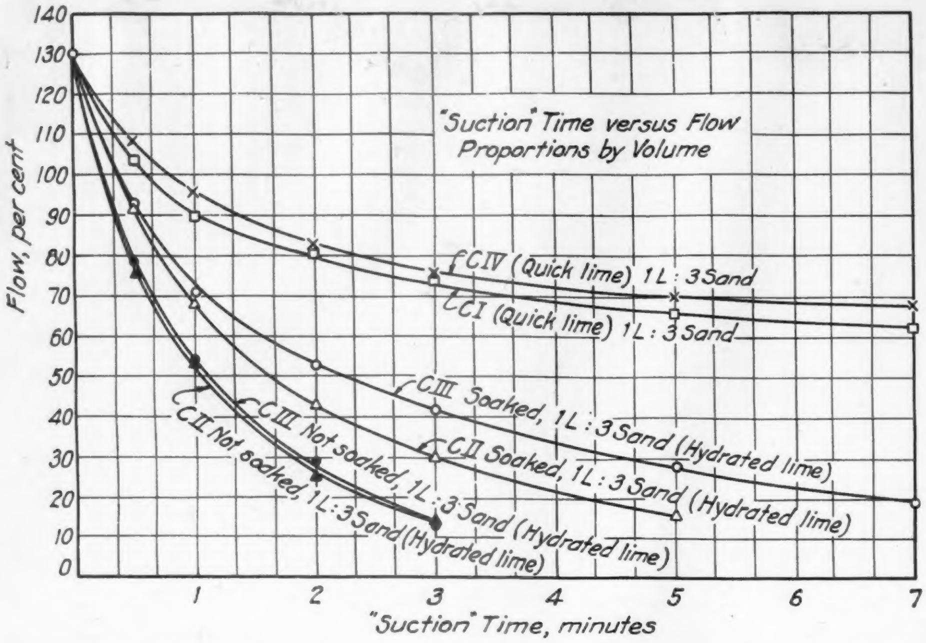


Fig. 6. Comparative rates of stiffening of lime mortars on porous base

of the four lime mortars on the porous base. The data for mortars C II and C III were obtained both with and without presoaking the limes. The extent to which the rates of stiffening of mortars C II and C III were decreased by soaking these limes for 24 hours prior to making the flow and suction tests is indicated in this figure.

It is observed (Fig. 6) that the rates of stiffening of mortars C I and C IV are much lower than those of mortars C II and CIII. Limes Nos. 1 and 4 used in mortars C I and C IV were quicklimes, slaked for a week prior to tests. Limes 2 and 3 of mortars C II and C III were hydrated limes. Limes 1 and 3 were high calcium and 2 and 4 were dolomitic. Apparently the rates of stiffening of these four limes under the conditions of test depended more on whether the lime was a slaked quicklime or a hydrate than on the fact that it was a high calcium or a dolomitic lime.

The curves for mortars C II and C III (lime not soaked) of Fig. 6 (also curves for mortars B IV, B II, B V and B III, Fig. 4 and B XII and B VIII of Fig. 5) were not continued further for the reason noted above concerning the use of the flow table. Values for flow lower than the points terminating these curves could not be obtained. These points marked the limit below which the mortar crumbled or rolled and did not spread or flow.

Portland Cement-Lime Mixtures

The curves in Figs. 7, 8 and 9 were all obtained with portland cement No. 1. The curves for the mortars made with the several mixtures of this cement and lime No. 2 would, if plotted in Fig. 7, almost coincide with the curves there shown of the corresponding mixtures containing this cement and lime No. 3.

The hydrated limes used in mixtures with the portland cements were soaked for 24 hours prior to tests in all cases. In obtaining the curve for mortar C III, Fig. 7 (lime and sand alone) the lime (No. 3) was presoaked.

It is seen from Figs. 7, 8 and 9 that the rate of stiffening of the mortar containing portland cement and sand alone, i. e., A I, was greater than that of any mortar containing this cement together with lime in the quantities indicated.

All of the above statements applying to the curves for mixtures of the limes with portland cement No. 1 are applicable to the curves of Figs. 10 and 11. These were obtained with portland cement No. 2 and limes Nos. 1 and 4.

Were the curves for mixtures of portland cement No. 2 and limes 2 and 3 plotted in Fig. 7, they would nearly coincide with the curves there shown for the corresponding mixtures of portland cement No. 1 and lime No. 3.

The curves of Figs. 10 and 11 differ from those of 8 and 9 in at least one noticeable respect. There is greater divergence between the curves for the 1 portland cement: 3 lime: 12 sand (by volume) mortars and the mortars containing lime and sand alone in Figs. 10 and 11 than is the case for the curves of corresponding mortars of Figs. 8 and 9.

All four figures (8, 9, 10 and 11) show less divergence between the curves for the 1P.C.:0.15L:3S and the 1P.C.:1L:6S mortars than might be expected. In the former mixture the proportions by volume are 1.15 volumes of cementing material (lime and cement) to 3 volumes of sand whereas in the latter case the proportions are 1 to 3. Thus the fact that the 1P.C.:0.15L:3S mortars were relatively richer in cementing materials may partially account for the fact that the divergence is not larger. In Fig. 7 the rate of stiffening of the 1P.C.:0.15L:3S mortar is seen to have been actually less than that of the 1P.C.:1L:6S mortar. It is seen in Table II that this was also the case for mortars YTa and YTd of corresponding proportions of lime No. 3 with portland cement No. 2.

In general it is seen that the substitution of lime wholly or in part for portland cement decreased the rate of stiffening on the standard porous base. This decrease was greatest when the quicklimes, slaked for one week, were used.

It will be well in this connection to refer again to the data in the fifth column of Table I. Consider for example the relative weights of dry hydrated limes contained in mortars XSa and XRa. The former contained 0.33 weight of lime No. 3 (high

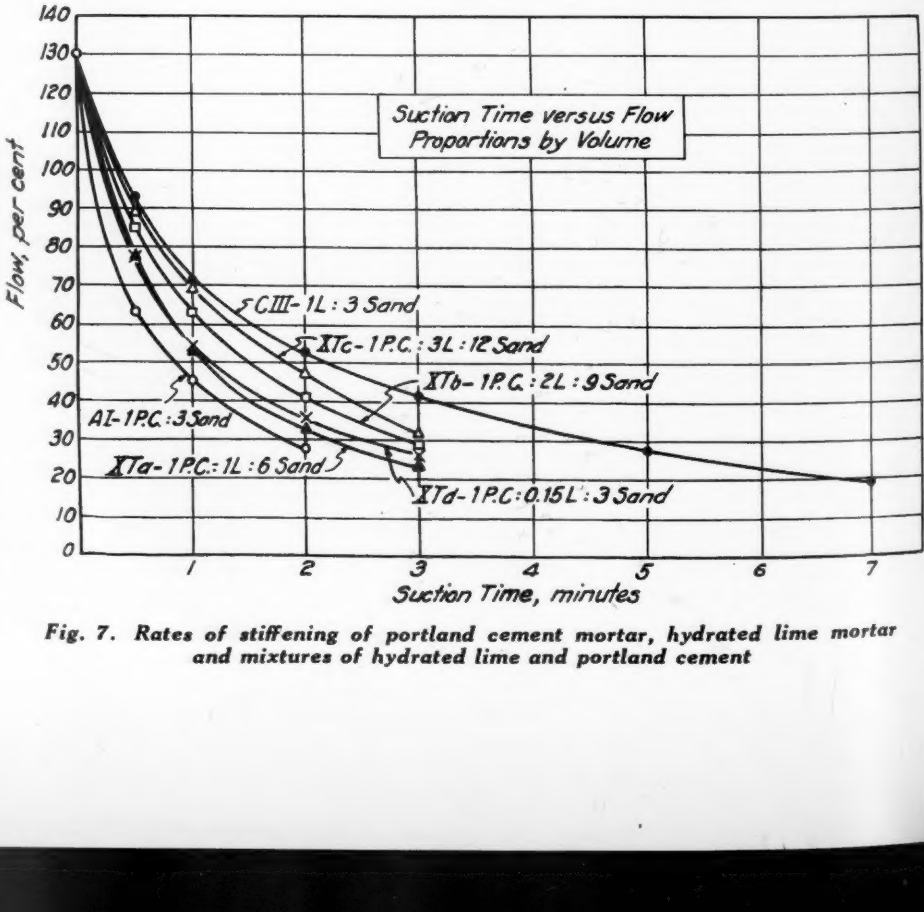


Fig. 7. Rates of stiffening of portland cement mortar, hydrated lime mortar and mixtures of hydrated lime and portland cement

calcium hydrate) to one weight of portland cement. The latter contained 0.42 weight of dry hydrated lime (as computed from the determination of water in the putty) to one weight of portland cement. The same weight of sand was in both mortars. It is altogether likely that the rate of stiffening of mortar XSa would have more closely approached that of mortar XRa had this disparity in relative masses of the two materials not existed.

Discussion

It is possible that with a different sand or with different proportions by volume of the sand used in this study, the relative positions of some of the curves may have been considerably changed. It is possible for instance, that mortar B VIII could have had greater water retaining capacity than either mortar B X or B XI had the proportions of cement to sand been 1 to 2½ rather than 1 to 3 by volume. If the study of the property, "water retaining capacity" can give data of real utility, then this study should be continued using different sands and volume proportions.

It is possible that the colloid content of a cementing material tends to increase the "water retaining capacity" of the mortar in which it is used. If it is then granted that "plasticity" is increased by increasing the colloid content, all other things being equal, it is reasonable to conclude that the "water retaining capacity" of a mortar (easily measurable) may be an index to "plasticity" itself. A great deal of difficulty has been experienced in trying to find some satisfactory measure of the "plasticity" of mortars. Bingham[7] mentions that "plasticity itself has hardly been measured, but rather some property instead which is supposed to be related to it, such as the amount of water required to bring a clay to a given consistency" etc.

[7] Eugene C. Bingham, Fluidity and Plasticity (textbook), 1922 edition, page 235 et seq.

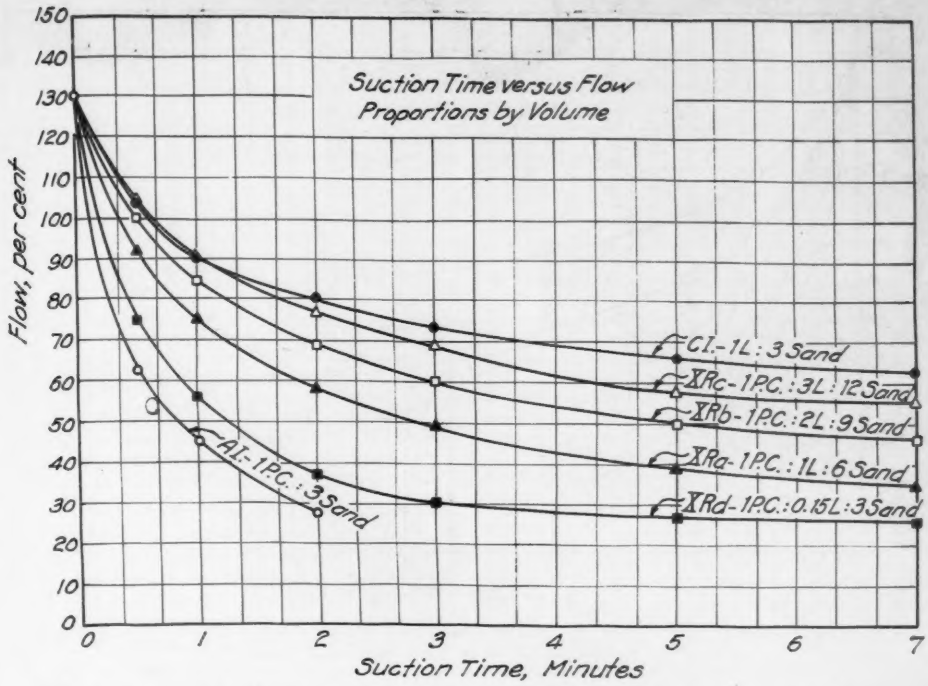


Fig. 8. *Rates of stiffening of high calcium quicklime (slaked one week) mortar and mortar mixtures with portland cement, on a porous base*

The curves shown in the preceding graphs indicate that with a given amount of suction certain mortars stiffen far more slowly than others. These differences are due primarily to differences in the degree of resistance to suction offered by the various mortars. To say that a mortar has a relatively high "water retaining capacity" is a concise way of stating that it offers relatively great resistance to loss of water by suction. If actual troweling of mortars can give one any notion as to their "plastic" properties then it can be said that those mortars depicted as having high "water retaining capacities" were indeed "plastic."

It is a well known fact that in so-called "harsh working mortars" there is a marked tendency for the water and solids to segregate on standing. Although all mortars have this tendency more or less, it is apparent that it is more marked in some than in others. "Water *carrying* capacity" would seem to be a suitable term to apply to mortars in this connection. A mortar in which the tendency toward segregation is slight may then be said to have a relatively high "water carrying capacity." It is obvious that the water that is thus separated from the solid by segregation can be drawn off by suction more quickly and easily than water that is not segregated but is occluded by the solid particles. On this basis a mortar of high "water carrying capacity" would be expected to have a high "water retaining capacity."

It is also well known that mortars and concrete mixtures in which there is a marked tendency for segregation to occur are known to be "sensitive to water." This means that the addition or subtraction of a relatively small amount of water causes a marked increase or decrease in the flow as measured on the flow table. This "sensitivity to water" in such mortars is especially marked at points above normal flow (100% to 115%). For such a mortar as compared with other mortars relatively less water is required to bring the mortar to a desired consistency. According then to Bingham[8] this condition would indicate a lack of "plasticity." Then if this condition is either a cause or an invariably attendant circumstance of the other condition, i. e., low "water retaining capacity" it is reasonable to assume that the resistance of a mortar to suction is as good an index to "plasticity" as the amount of water required to bring the mortar to a given consistency.

[8] Loc. cit.

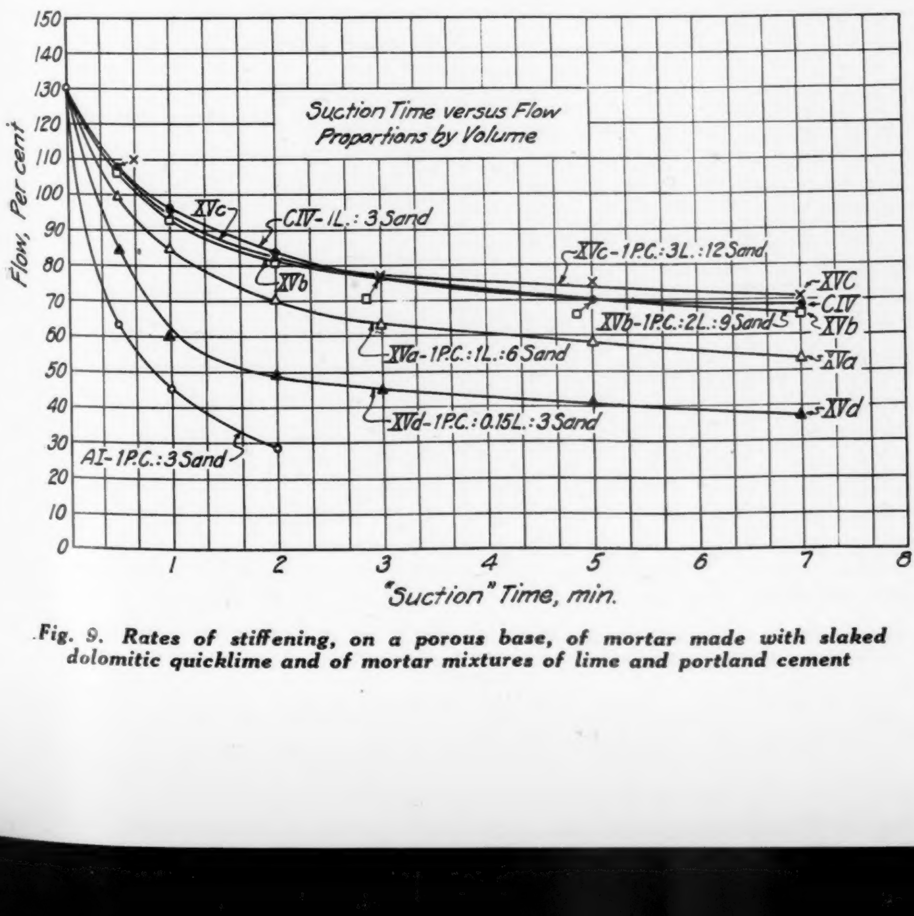


Fig. 9. *Rates of stiffening, on a porous base, of mortar made with slaked dolomitic quicklime and of mortar mixtures of lime and portland cement*

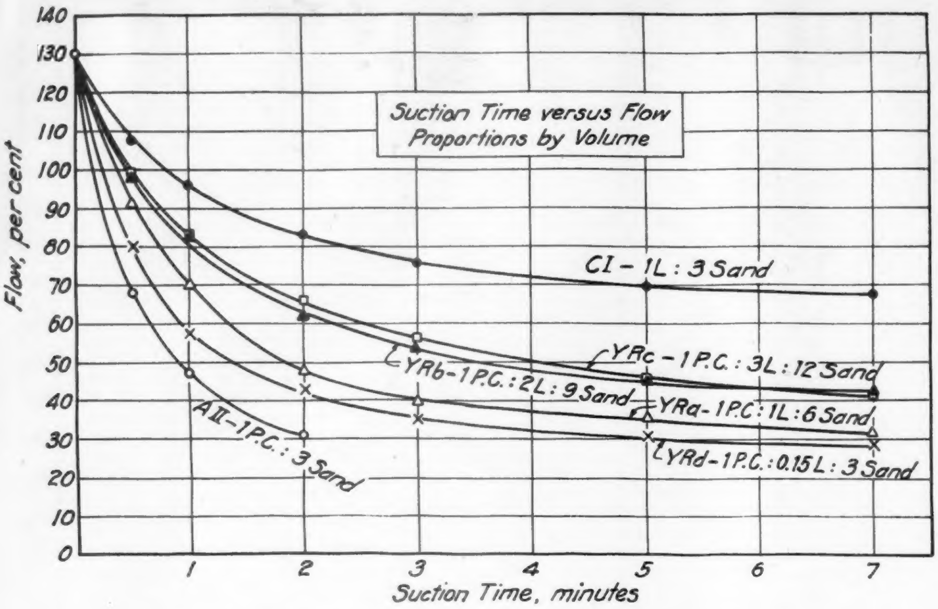


Fig. 10. Rates of stiffening, on porous base, of high calcium quicklime mortar and of mixtures of lime and portland cement

None of these statements is however proved or established. They may possibly serve as good working hypotheses. The Emley plasticimeter measures the resultant of the factors "water carrying capacity," "water retaining capacity" and resistance to deformation of the material at any instant when its water content *may be determined* if it is not known. Working with mortars that are not adaptable to the Emley plasticimeter one might study these factors separately, then later by combining the data evaluate the resultant of all of these factors. The fundamental principles involved in the design and use of the Emley plasticimeter serve as a guide in this type of work.

[9] J. W. McBurney, The Water Absorption and Penetrability of Brick, Proc. Am. Soc. for Testing Materials, Vol. 29, Part II, 1929, page 711.
[10] L. A. Palmer, Water Penetration through Brick-Mortar Assemblages, J. Clay Products Inst. of America, Vol. I, 1, 1921, page 19.

It must be remembered that many types of units have little or no suction. And again it is well to bear in mind that past work[9, 10] has indicated that the rate of absorption rather than the total per cent absorption is the really important consideration. There are, however, types of units that have "high suction" and these if properly used have excellent bonding qualities[11] when in contact with mortar. The suction of such units may be reduced to any desired degree by carefully wetting them. It is not always practical to do this, especially in freezing weather and if a mortar can be found of sufficient "water retaining capacity," wetting the units may not be necessary. With such a mortar, stiffening due to water loss is less rapid and the mason would experience less difficulty in making good contact between mortar and unit. The human equation is probably the most important factor involved from the standpoint of good construction and anything that is helpful to the workman is very desirable.

[11] L. A. Palmer and J. V. Hall, Durability and Strength of Bond between Mortar and Brick, Bureau of Standards Research Paper No. 290.

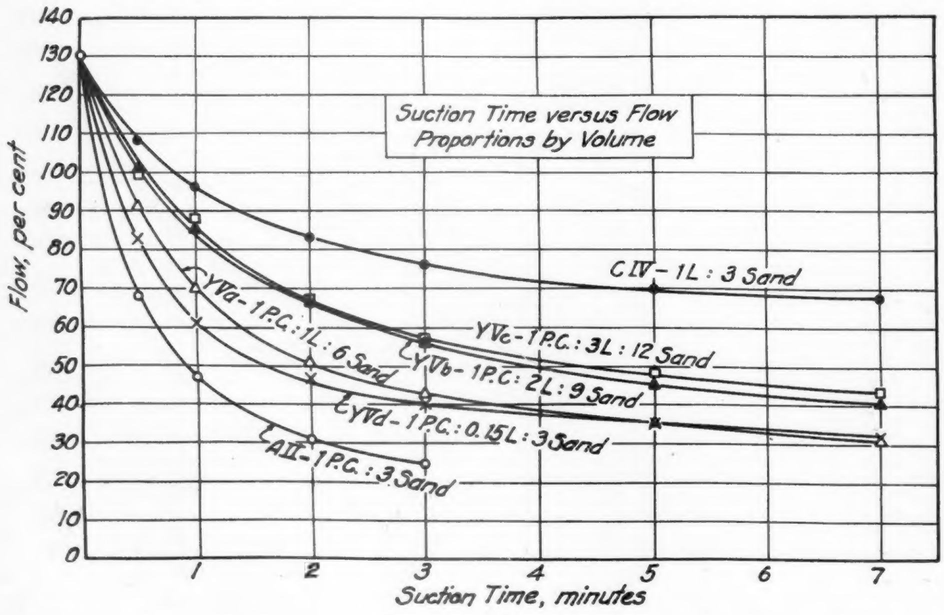


Fig. 11. Comparative rates of stiffening, on porous base, of dolomitic quicklime mortar and mortar mixtures of lime and portland cement

Conclusions

1. The rates of stiffening on a standard porous base have been studied with 50 different mortars.
2. There was a considerable degree of variation among the mortars from the standpoint of "water retaining capacity."
3. Certain mortars of widely different compositions did not differ widely with respect to rate of stiffening.
4. In general, substitution of slaked lime putty or soaked hydrated lime either in part or altogether for portland cement reduced appreciably the rate of stiffening on the standard porous base.
5. Of the 12 masonry cements studied, those made from natural cements and modified by the addition of stearates at the factory had the lowest rate of stiffening.
6. It is believed that a high "water retaining capacity" is an essential property in a mortar when it is used with units having a high rate of absorption. Furthermore, this property may be an index to "plasticity" as others have indicated and this is essential with all types of units.
7. The results presented should be indicative within the limit studied of the water retaining capacities of mortars as they are actually used in building. They were not obtained primarily for the purpose of studying various cementing materials.
8. The possibility of applying the principles of the Emley plasticimeter to mortars not adaptable to this instrument is indicated.
9. A method is described whereby the relative workabilities of different mortars on a porous base may be evaluated. The comparative workabilities are independent of the initial consistencies of the samples.

Acknowledgments

The authors are grateful for the helpful cooperation of Messrs. Rogers, Dwyer, Emley and D. E. Parsons of the Bureau of Standards staff. They are grateful also to those industries who supported this investigation and furnished the necessary materials.

Behavior of Clay Gels Under Small Pressures

ACCORDING to a paper by R. M. Woodman and G. W. Chapman in the June 3, 1932, issue of the *Journal of the Society of Chemical Industry*, the swelling under pressure of bentonite and gault gels depends on the ratio of SiO_2 to Al_2O_3, on the base saturating the gels and on the age of the clay suspension. The apparatus used, permitting measurement of the swelling of the clays under small excess pressures, is described.

The Manufacture of Portland Cement*

Part VI—Properties of Cement and Effects of Components

By S. E. Hutton
Consulting Engineer, Seattle, Wash.

Editors' Note

***IN THIS ARTICLE** the relations between the properties of portland cement and its components and constituents are treated.*

The importance of correct research, the relation between cement and concrete qualities, and the qualities of strength and durability are discussed.—The Editors.

THE statements made in this article, with respect to the relations of cement properties to cement composition, and with respect to the peculiarities of raw materials and of cement constituents, are based on data that seem to be the most reliable and most rational material at hand at the time of writing. Several points should be made clear in that connection, for many will likely disagree with one or another of the statements made.

In the first place, nowhere outside of mathematics does there seem to be any field wherein many, if any, unqualified statements can be made without great probability of their lacking something in the way of precision or of comprehensiveness, or without their conflicting with the opinion of someone, if not with facts to the contrary.

Second, much of our knowledge is not and cannot be the result of direct observation, but is based on indirect evidence, that is, on observations of related phenomena that by a course of reasoning convince us or encourage us to believe that some other thing is or is not true. Here is our greatest pitfall. Whenever we fail to take into account any one of all the influencing circumstances, or base our reasoning on very limited data, we may arrive at false conclusions. In any number of cases, thorough investigations have proved highly respected and widely-held beliefs to be wrong.

Third, with regard to any phenomenon which involves many intricate factors, many false notions are always current, because it is a simple matter to observe an effect and one of its causes, or some concurrent condition, while ignoring other influences. Many psychologists have arrived at the conclusion that popular beliefs as to matters that have not been thoroughly investigated are likely to be wrong, because they are likely to be based on novel and exceptional conditions, which attract attention, rather than on usual conditions or on known cause-and-effect relations. Only very careful, thorough and precisely controlled experiments can be depended upon for reliable information with respect to complex problems, and then, frequently, because complete and accurate quantitative relations cannot be worked out, only tendencies may be known. Under ideal circumstances the underlying theory is understood and local conditions are known accurately. Then calculations and forecasts can be made with the same confidence that the electrical engineer has in his calculations as to circuits, or that the structural engineer has in his determination of stresses. In many of its phases, cement technology has not yet reached that stage.

Fourth, we are disposed to be partisans, and to be more inclined to defend our beliefs than to find the facts. I have known a number of men in a meeting to pass a resolution expressing an opinion with regard to certain electrical equipment, which in effect was a declaration that Ohm's law was not true as to electrical circuits in their industry. They were ignorant of certain fundamental requirements, and of some deficiencies in their own performances, but they held strong views based on things that were obvious, and mistook unanimity of opinion for convincing evidence.

No matter how positively they may appear to be made, the statements contained in this chapter, with more or less obvious exceptions, should be regarded simply as reasonable inferences from the best evidence obtainable—in other words, as one should regard any other statement. Right or wrong, each statement may be taken as a reminder of something to be taken into account in practice, particularly when troubles occur, or when changes are contemplated. Some of them may be really proved to be wrong, at least under some circumstances. Obviously, not every qualifying condition could be stated.

Value of Cement

Cement is useful and valuable because, when mixed with water, it produces an adhesive paste, with which crushed stone, gravel and sand can be made into a plastic mixture that can be cast in molds, and because the paste sets and hardens, binding the aggregate together in a stone-like mass.

From the standpoint of the builder, the desirable qualities in cement are such as will contribute to low cost in making and placing the plastic mixture, and such as will contribute desirable qualities to the resulting stone-like mass, chiefly strength, durability, and good appearance. The cement manufacturer is interested not only in producing what the buyer of his product wants, but, also, in doing so at low cost. He therefore is concerned with raw materials that can be obtained, ground, proportioned, and mixed at low cost, that will produce a raw mix that can be burned thoroughly at a reasonable temperature, and that will make an easily ground clinker and a good cement.

Sources of Cement Qualities

The qualities found in cements are consequences of the chemical and physical properties of the components entering into them, the physical treatment given raw materials, the constituents formed by the chemical reactions in the kiln, and the physical treatment of clinker. Hence, it is worth while to discuss in considerable detail the qualities desired in cement, and their relations to raw materials, processes, and cement constituents; the components of cement and their relations to cement qualities; and the constituents and their properties. Such a series of discussions naturally involves numerous repetitions, but the multiplicity of details and the complexity of their relations justify many repetitions.

Intricacies of Quality Relations

One of the most useful fundamental conceptions of mathematics is that one of variation, according to which one quantity is said to vary directly as another if the ratios of their corresponding abstract values are a constant. Thus the length of a journey varies directly with the time spent on it, if one moves at a constant speed, that is, if all ratios of distance traversed to time consumed have one value. Add to this the conception of inverse variation, in which one function decreases directly as another increases, so that the products of all corresponding values are a constant, and we have the two simple relations between variables. A valuable technical application of these concepts is seen in Ohm's law, which states that the current flowing in an electrical circuit varies directly with the total electromotive force applied to the circuit and inversely with the resistance of the circuit. In general, the results we get vary directly with the efforts we put forth and inversely with the resistance we encounter.

Unfortunately, few relationships are as simple as those expressed in Ohm's law. Hardly any phenomenon of any importance is a function of only one or two variables; in many cases the ratios or products of corresponding abstract values are variable; and in many of our problems we know neither the important variables nor their exact relations to other variables or to the final result. This is true of the relations between the desired qualities of cements and their components and constituents.

Importance of Fundamental Researches

The relations between the results of a phenomenon and the variables entering into the phenomenon may be so numerous and so intricate that from a tabulation of the values of known variables no definite relations can be found between the results, such as strength of cement, and contributing causes, such as cement constituents. The conclusions that might be drawn from one set of data are frequently directly opposite to those that might be drawn from another equally reliable set, because data are incomplete, or because the effects of one change offset the effects of another. If many variables are involved, and if experiments covering widely different combinations of them are made, the tabulated results usually show the futility of seeking a knowledge of fundamental relationships through incomplete statistics. Statistics, according to Mark Twain, are the lowest form of literature. They are also the lowest form of technical and scientific data.

In a phenomenon involving many variables, the exact relations between two of them can be found only by holding constant all but the two variables under consideration, while the effect on one of changes in the other are observed. Thus relationships, not shown, and perhaps actually concealed in statistical data, are found. Much of such information is, so far, and may always be, qualitative rather than quantitative, but it is, nevertheless, useful as a guide to judgment or to experimental work. A wise manufacturer makes an effort to do all the things which tend to produce the results he wants, and to avoid doing the things which tend to defeat his purposes—if he knows what things have such tendencies.

Relation Between Cement and Concrete Qualities

Cement is not a building material in the sense that structural steel shapes, bricks, and lumber are. It is one of the components of a structural material, concrete, which includes many other variable components in addition to cement. The ideal structural material would not expand and contract with changes in temperature and moisture content, would be impervious to moisture, inert toward chemicals, not vulnerable to attack by organisms; and it would, therefore, be free from the effects of forces that destroy structures. There is no such building material. Even the aggregates in concrete may be affected by destructive forces, and the ideal cement might, therefore, be considered to be one capable of making a binding agent equal in resisting power to the aggregate with which it is used.

It is not clearly known what the most desirable qualities of cement are, and it is much less clearly known whether one cement could be made to embody them all, or whether special cements could be made on a commercial basis to resist special combinations of adverse conditions. As requirements are more clearly defined and testing methods are improved so as to show closer, more coherent, and more rational relations between cement properties and concrete qualities, and as more is learned about the technology of both cement and concrete, the possibilities and the limitations in the use of concrete will be better understood. The strength of concrete and its resistance to weathering have been greatly improved by better cement and by better practice in concrete making and in structural design, and further improvements may be expected, but good practice in any art is limited to making reasonable demands upon and by recognizing the inherent qualities of the materials available.

Cement is not unique in the particulars referred to here. Steel, for example, while it has been improved in recent years, and is now available in various grades and in various shapes for special purposes, is variable in its physical and chemical properties, and is a ready victim of many destructive agencies if exposed to them. It is possible to adapt steel to some conditions and not to others. It must be so with concrete.

So far, the requirements of concrete are summarized in strength and durability. Both qualities may involve, to greater or less extent, not only the adhesive and mechanical force-resisting properties of the hardened cement and water paste, but its volume changes with changes in temperature and humidity, and its ability to resist chemical action.

Strength

Cement really has no such property as strength, so when we speak of the strength of cement our interest is actually in the strength of concrete, which is a function of many other things in addition to the strength of a hardened paste made from cement and water. The strength of a hardened cement and water paste varies not only with the properties of the cement used, but with the relative quality of water used in it (water-cement ratio), its age, and the temperature and humidity to which it has been subjected. Concrete strength varies with all of the qualities and conditions that affect the strength of cement and water paste, and also with the kind, condition, and assortment of sizes of aggregate used.

In order to test cement for the purpose of determining its strength-producing effect in concrete, it is necessary actually to test mortar or concrete made from it, and to standardize testing methods and conditions, so as to reduce to a minimum variables other than those introduced in the cement. Although concrete is regarded as being suited to carrying only compressive and very low shearing stresses, both compression and tensile tests are made. So far there have been devised no testing methods which are entirely satisfactory in giving precise and reproducible results, and in showing a definite relation between the cement (or the laboratory test piece) and the strength of the concrete in place in a structure. Not only the standard cement specifications, but the standard methods of testing cement in general use in America, are established by the American Society for Testing Materials, whose special committees are constantly endeavoring to improve them.

The compressive strength of cement is due almost entirely to the calcium silicates, which constitute 65 to 80% of it. Tricalcium silicate reacts readily with water, especially in finely ground cement, and is the chief contributor of strength up to ages of about 28 days, when strength from the hydration of dicalcium silicate becomes apparent. At the end of about one year the two silicates show about the same strength. The outstanding characteristics of high early strength cement are high content of tricalcium silicate, and fine grinding. Some show retrogression in strength after 30 to 60 days, probably on account of free lime, or because lime is leached out of test pieces. Fine grinding, rather than content of tricalcium silicate near the greatest theoretical value, is probably the more rational means of realizing high early strength.

Tricalcium aluminate and tetracalcium alumino ferrite detract from the strength of cement, but not to the full extent to which they replace the silicates. That is, they contribute less to strength than equal quantities of the silicates would. However, they are both unavoidable and indispensable in commercial cements, and are present to the extent of 15 to 22% in good cements.

Although gypsum is present in cement primarily for the purpose of controlling setting time, it also offsets or prevents the adverse effects of tricalcium aluminate on late strength and of tetracalcium alumino ferrite on the early strength of cements.

Free lime has an adverse effect on strength, as a diluent, by reducing the tricalcium silicate content, and by introducing a disruptive force if its hydration is not complete before setting and hardening are well advanced.

Though many cement technologists are of the opinion that no such thing as the overburning of clinker is possible, a number of precise experiments indicate that heating a mix beyond the lowest temperature at which reactions can be completed makes the resulting cement slower to react with water, and consequently reduces strength up to ages of two or three months. It appears that high-early-strength cements, especially, should not be overburned.

Cements frequently show lower results with

increased age in tensile strengths of briquets, and higher results in compression. The shape of the briquet, and a consequent uneven distribution of internal stresses, can account for the phenomenon.

Storing specimens in running or in chemically contaminated water frequently causes both tensile and compression tests to show lower strengths at later stages. This is likely to show greatest effects on cements high in tricalcium aluminate and tricalcium silicate due to reactions on or the leaching out of soluble hydrates.

The addition of certain chemicals, such as calcium chloride or chlorine, to cement will cause it to develop early strengths above normal, while others, such as sugar, will reduce or destroy its strength-developing qualities. Heat hastens the development of strength, while low temperatures retard or prevent it.

Durability

Durability is a term without much significance except as specific conditions are considered, for anything can be destroyed, and anything is permanent if not subjected to destructive forces. Concrete is almost never free from changes in temperature and humidity, and from the resulting stresses. In some applications it may be subjected to liquids which tend to dissolve or to combine with some of its components. Any of the forces may be destructive.

Both the aggregates and the cement-water binder in concrete expand with rise in temperature and with the absorption of water, and contract with reduction of temperature and of moisture content. Concretes that are dense, and which contain but little more binder than is sufficient to fill the voids between aggregates, change least in volume with changes in moisture content. The composition of cement may have some bearing on volume constancy, but the effect of controllable variations is probably too small to be of practical importance. Structural provisions, such as the contraction joints in pavements, must be made to prevent destruction of concrete by expansion and contraction.

The durability of concrete is reduced by using an excess of mixing water, by not using sufficient cement or a proper quality or assortment of aggregates or proper placing methods to secure dense and uniform concrete, and by improper curing methods. Porous concrete is destroyed by the freezing and swelling of water absorbed in its pores, and by the crystallization of certain reaction products when subjected to solutions of sulphate salts, and by the leaching out of hydraulic compounds when immersed in solutions of magnesium salts.

Concretes vary in their abilities to resist the disintegrating effects of acid and alkaline ground waters, and sea water. Disintegration is due very largely to faulty concrete making, but cements are attacked by various chemicals found in sea and ground waters. The sulphate ion seems to be most active, and to react chiefly with tricalcium aluminate in cement. The magnesium ion apparently attacks all constituents of cement, but it is less destructive than the sulphate ion. Sulphates, reacting with calcium aluminate, produce calcium sulphoaluminate, which occupies a volume much greater than that of the cement constituents from which it is formed, and consequently exerts a disruptive force within the concrete. Magnesium salts exert a disintegrating effect by causing an exchange of bases, and the leaching out of hydraulic compounds. Their effects are frequently exhibited in the "sanding off" of concrete surfaces.

Resistance of cement to disintegration in sulphate solutions is improved by reducing the content of tricalcium aluminate, either by reducing the alumina content or by increasing the iron content so that tetracalcium alumino ferrite will be formed at the expense of the tricalcium aluminate. Tests of a number of commercial cements in sulphate solutions have shown that those having iron oxide and alumina present in about equal parts, and in the lower percentages, were more resistant than others in which alumina greatly exceeded iron oxide, and in which the total content of the two was greater.

(*To be continued*)

Meeting of Japanese Portland Cement Engineers

A REPORT of the twentieth general meeting of the Association of Japenese Portland Cement Engineers, held at Tokio, November, 1931, has been published in booklet form by the association. Some 200 members and guests were present for the three-day meeting. Among other matters, rapid hardening portland cement was discussed and the Committee for Standard Specifications was requested to prepare tentative specifications. Papers were read on various subjects, including: effect of fine grinding; effect of small amounts of magnesia on color and formation of alit; photoelastic study of cement mortar test pieces of the beam type; relation between mortar and concrete strengths; relation between compressive strengths of concrete and of plastic mortar, and others.

Gypsum in Canada, May

GYPSUM production in Canada during May reached a total of 66,139 tons, as compared with 23,087 tons in April and 95,240 tons in May, 1931, according to the Dominion Bureau of Statistics. During the first five months of the current year the Canadian production totaled 112,300 tons, a decline of 33.1% from the total for the corresponding period of 1931.

Crude gypsum exports from Canada amounted to 11,110 tons, valued at $12,512; in April no crude gypsum was exported from Canada.

Asbestos in 1931

CONDITIONS prevailing in the domestic unmanufactured asbestos market in 1931 were similar to those in 1930, namely, lessened demand and declining prices. Lowered prices did not have the effect of stimulating demand, and when quotations continued to decline, activities were temporarily suspended by some operators, an advance summary by the Bureau of Mines states.

Canada supplied about 95.4% of the total imports of unmanufactured asbestos into this country in 1931, as compared with 95.9% in 1930; Russia came next, furnishing 2.8% of the total in 1931, as compared with 2.2% in 1930; and Africa supplied 0.98% in 1931, as compared with 1.54% in 1930.

Phosphate in Tennessee

IT IS REPORTED that a slight increase has been noted in inquiries from the high phosphorus blast furnaces for phosphate in the Tennessee district. A few inquiries and a very few orders have been received from farmers for direct application, with a general undercurrent of interest in large acreage of phosphate-bearing lands in the hands of original owners, defunct operators, and of holding companies. This latter situation is apparently due to the belief that if phosphate lands ever were worth buying and will ever again be in demand, present prices at which they can be acquired are certainly bargains.

A noticeable decrease in activities, both of large and small operators, has taken place, augmented recently by heavy rains which forced hand mining and trucking to shut down entirely. It is expected that improvements will be made to these operations soon to eliminate this difficulty.

An interesting exhibition of tobacco is being made in the Columbia district by a prominent chemist. He applied some heavy side dressings of nitrogen and potash on his soil, abnormally high in phosphorus, and the crop that resulted was exceptional.

Canadian Talc and Soapstone, 1931

THE PRODUCTION of talc and soapstone in Canada during 1931 was valued at $157,083, as compared with an output valued at $186,216 in 1930, according to finally revised statistics just issued by the Mining, Metallurgical and Chemical Branch of the Dominion Bureau of Statistics at Ottawa.

Soapstone produced in Quebec is shipped in the form of blocks and powder; in Ontario a high-grade talc is mined and ground near Madoc. Shipments from the latter province were made to Europe, the United States and points in Canada. Some crude talc was produced during 1931 at Leechtown, Victoria mining division, British Columbia.

The Agricultural Lime Market*

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ONE of the early tasks assigned to me at the Rhode Island Experiment Station, in 1890, was the installation of 11 soil tests with fertilizers on Indian corn in the different counties of the state. Nitrogen, phosphoric acid and potash were applied singly, and in combinations of two, and of all three. In addition, nitrogen was used in three different amounts in each of the forms, dried blood, sodium nitrate and ammonium sulphate; always with the same amount of the two mineral fertilizers. The first year, at Kingston, each increase in the amount of the ammonium sulphate resulted in a marked decrease in growth. At Hope Valley, R. I., it was highly inferior by the second year and at Abbott Run a similar tendency was noticed the third year. The toxic effect was so bad in Kingston, the second year, that the corn only reached the height of a few inches in the course of the season.

In the winter of 1890-91 I made a search of American and European literature for accounts of experiments with ammonium sulphate in order to ascertain, if possible, the probable reason for its ill-effect. Professor Wagner of Darmstadt, Germany, had published in 1887 (Düngungsfragen, pp. 50-2) a report of experiments with it in which bad effects were noted for a time; and notwithstanding that partial recovery followed, the yields were still poor, and Wagner remarked, "It remains for further experiments to throw light upon this practical and very important question." Similar occasional ill-effects, or at least inferior effects of ammonium sulphate, had been recorded by Baessler, Klein, Birnbaum, Sebelein, Heinrich and Samek. Professor Maercker, of Halle, found ammonium sulphate less efficient for beets than for other crops, but he asserted that the claimed injurious effect of ammonium salts was not proved, and that it certainly does not occur on "normal" soils. In Germany, in 1890, Schultz-Lupitz (Kalidungung auf leichtem Böden) wrote that the soils of his district became sour and unfit for the economical production of plants, but he made no reference to the making of actual tests for acidity. Hilgard of California, a native of Germany, once mentioned that "saurer Sandboden" (sour soil) was an expression frequently used in referring to the uplands in the vicinity of Berlin "and in the Mark Brandenburg at large." W. Detmer and Hübener, in Germany, had already mentioned the fact that sandy soils tend to become acid.

*Extracts from a paper read at the 14th annual convention of the National Lime Association, Cleveland, Ohio, May 25, 1932.

Professor Deherain, in France, had already called attention to injurious effects of large applications of ammonium sulphate, noted by him in the period between 1876 and 1882, but he concluded his discussion of the matter by saying that the reason for the ill-effect "remains to be ascertained."

Professors A. Müntz and A. C. Girard of Paris mentioned in 1891 an experiment on an "acid" soil in Brittany in which certain plant residues underwent nitrification, but ammonium sulphate did not. This was attributed to the fact that the plant, unlike ammonium sulphate, contained some lime.

Early Comments on Soil Acidity in English

A. Voelcker, long connected with the Woburn Experiment Station in England, wrote in the *Journal of the Royal Agricultural Society* in 1865 that he had found green vitriol (proto-sulphate of iron) and an excess of organic acids injurious to plants. Their presence, he asserted, was readily revealed by bringing a strip of blue litmus paper in contact with the moist soil; and if the paper turned rapidly red he was sure the soil contained something injurious to plant life. He even went so far as to state that "All good and fertile soils either have no effect upon red or blue litmus paper or show a slight alkaline reaction; that is to say, in a wet condition they restore the blue color to reddened litmus paper." This we now know is contrary to the facts, for many kinds of plants thrive better in soils that are still somewhat acid than they do after the soil is made neutral or alkaline.

In 1840 Jackson, in his report of an agricultural and geological survey of Rhode Island, mentioned the soil of a farm north of the city of Providence which consisted of "ancient granite diluvium charged with decomposed vegetable matter in an acid state," but it was not stated whether the acidity was proved or assumed.

Early in the last century Ruffin in Virginia wrote of sour soils and of the benefit derived from marling, but it does not appear that he actually tested the soils of which he wrote. On the contrary, he apparently inferred that they were acid because common sorrel, which is acid to the taste, grew there abundantly before marl was applied.

Soil Acidity Long Neglected or Forgotten

Notwithstanding these early references, and possibly due to the advent of commercial fertilizers, the acidity of soils became generally neglected by European experimenters during most of the period from 1890 to 1910, as shown during that time by the dearth of references to the occurrence of an injurious degree of acidity in upland, well-drained soils in Europe. In a booklet on lime issued by the Board of Agriculture of Scotland the author lamented the fact that "liming in Scotland went out of fashion 40 or 50 years ago, and that by 1900 the practice had almost become extinct." He asserted that the country was suffering more from a lack of lime than from any of the usual fertilizer elements and that the more highly the land was farmed the greater the need became.

A search of a prominent German abstract journal (*Jahresbericht für Agrikultur-Chemie*) for the period, 1890 to 1900, fails to reveal a single reference to soil acidity in the subject index, although there are a few references to experiments with lime. In fact, but little attention was paid to it in Europe generally from 1885 or earlier to about 1910; whereas during the last 20 years few if any agricultural subjects have attracted equal attention in foreign countries. It was undoubtedly the work in this line in the United States that finally aroused the Europeans to the widespread, and serious, consequences that result from neglect of the chemical reaction of the soil.

For a period of nearly 15 years German agricultural chemists in particular were explaining on other grounds effects that were unquestionably due to soil acidity. This, alone, gives evidence that, while soil acidity was mentioned by many of their earlier writers, they had apparently during this period neglected or ignored it. Today, however, all is changed.

In this country there have always been farmers in certain sections, particularly of Virginia, Pennsylvania and New Jersey, who have used lime because they found it beneficial, and because their European ancestors had brought them up to do so. It is doubtful, however, if the use of lime in the United States would ever have attained its present proportions had it not been for the recognition by chemical means of excessive acidity in the upland, well-drained soils of this country.

That dynamic propagandist Hopkins, of Illinois, was a powerful factor in the Middle West in calling attention to the need of lime. Our thanks are due to the late Dr. Frear, of Pennsylvania, for one of the best general publications on lime and its use that has been written in the United States. For outstanding, long-sustained and well-conceived investigations in the field of lime and liming, Dr. McIntire, of Tennessee, with the able support of Director Mooers, has earned recog-

nition perhaps to a greater extent than any other American. However, the excellent work of Wherry and others in developing color tests for the determination of the soil reaction *on a numerical basis* deserves special mention. If space permitted many others should be mentioned for their valuable contributions to methods of testing soils and for other lines of research. To all of them we are indebted today for the great volume of experimental data on this general subject of lime and its use and on the occurrence of injurious soil acidity throughout a large part of the United States.

Pioneering a Rocky Road

When, in 1891, the writer reported that he believed the toxic effect of the ammonium sulphate was due to a lack of nitrifying organisms or to soil acidity and asked for a chance to apply some garden soil to a part of the ammonium sulphate plots and both soil and lime to another part, he was refused on the ground that "it would probably not amount to anything." However, persistence finally won, but not until the summer was well advanced and the corn on the plots had been up for some time. At that time the garden soil and lime had to be worked in between the rows, and a thorough job was impossible; nevertheless before the end of the season some evidences of recovery were here and there visible. By the next spring the lime had become so well incorporated with the soil that as the season progressed its effects were nothing short of marvelous. Where the garden soil only was applied no benefit was observable, but where lime alone and lime and soil were both used, the year before, the corn on the ammonium sulphate plots instead of remaining only a few inches high during the entire season grew wonderfully, and better with each increase of the application. The corn had a dark green color and showed remarkable vigor.

While searching the literature relating to experiments with ammonium sulphate I went to the Bussey Institute, connected with Harvard University, to consult the library, and in conversation with Professor Storer I told him I was planning to use some lime in the hope that it would correct the soil acidity sufficienlty to overcome the ill effect of the ammonium sulphate. In response he placed his hand on my arm in fatherly fashion and asked me if I did not recall the case of a German who applied lime to his garden with the result that it set ammonia free and caused injury. I told him I did, but that the German used too much. However, I could not convince him that it would work—he still thought I was "barking up the wrong tree."

In the spring of 1893 I secured an assignment of four 2/15-acre plots where I could experiment as I pleased. All were fertilized alike with phosphoric acid and potash, two received ammonium sulphate and two sodium nitrate. One plot of each pair was then limed. That year 38 different kinds of plants were grown in rows across the four plots. In the years that followed the number reached about 200. That season the lupine showed injury from lime, whereas lettuce, spinach, beets and sorghum either nearly died or failed to produce a remunerative crop without lime. The results showed that of the small grains, barley was the most injured by soil acidity. This was followed in turn by wheat, oats and rye. Later experiments showed better growth of watermelons without lime, whereas cantaloupes failed to produce any mature ripe fruit where lime was omitted. The Norway spruce was injured by lime where plums and cherries could not be grown with full success without it.

Lime Manufacturers Showed Little Interest

The results of this experiment in 1893 were so striking that I sent an invitation to every lime company in New England, whose address I could obtain, to visit the station and observe them. However, none came and only one (in Rockland, Me.) acknowledged the letter. In fact I do not recall any visit by a representative of a lime company until several years later. The following winter the director of the Rhode Island station after telling a colleague that we believed more attention should be given to liming was told that it was "all rot," that he had tried lime in his state and it was not needed. Unfortunately he used only a few hundred pounds to the acre and grew plants that were not seriously injured by considerable acidity.

Several years later the late Professor Johnson, then director of the Connecticut Agricultural Experiment Station, placed his hand sympathetically on my shoulder and remarked, "I used to talk lime but got over it," to which I replied that he got over it too soon. As late as the spring of 1900, when Bulletin No. 69 of the Rhode Island station was being prepared for the printer, my superior officer refused to allow me to have the word lime in the title on the cover, for he said my lime work had made the Rhode Island station ridiculous, and had made me the laughing-stock of the whole country. The bulletin was therefore given the title "A Study of Plant Adaptations." When my first bulletin on potato scab was ready for publication in which I advanced the idea that the chemical reaction of the soil was a powerful factor in increasing or lessening the disease, when the causative organism was present, a determined effort was made to have it withheld from publication. However, I finally won my point and a few years later had the satisfaction of having a German scientist, Professor Hollrung, give me and my assistants credit for having completely established the fact two years before one of his German colleagues claimed to have made the discovery.

The first real recognition of the value of these Rhode Island experiments was by the late H. W. Collingwood, then editor of *The Rural New Yorker*, and by Rowland Hazard of Peace Dale, R. I. The former, after a visit to the station, devoted a column or two for several weeks to an account of the work. The latter had a booklet containing reproductions of the photographs of the plants printed at his own expense and distributed at the Washington county, Rhode Island, fair, of which he was president. During this period, and even later, the secretary of the State Board of Agriculture of Rhode Island ridiculed the work. It is but fair to state that he was neither a chemist nor an agronomist. Today we all know the battle has been won, for the existence of acid soils and the need of lime have gained universal acceptance.

Growing Need of Lime in Peach Orchards

Lime-sulphur has become the standard spray for peach trees for the prevention of leaf curl, but there is a feature connected with its use to which too little attention has been called. I refer to the inevitable increase of soid acidity. This is due to the fact that the amount of sulphur used is so great that when it has been changed into sulphuric acid in the soil, the quantity produced is in excess of what the lime used with it is able to neutralize. The grower is usually unconscious of the loss he is sustaining in consequence of the creation of this condition, for the reason that he still continues to get a fair crop unless the conditions become very extreme. This is due to the fact that the peach, even on an acid soil, is not seriously and suddenly affected by a considerable increase in acidity. Nevertheless, upon liming a wonderful improvement in vigor and in the yield and quality of the fruit will often be noticed.

It has been the writer's privilege to suggest the use of lime and to observe the wonderful increase in yield in a Hudson river peach orchard on which the owner was getting such good crops that the idea of the need of lime had not suggested itself. Generally one is inclined to be content and to fail to undertake an improvement in methods unless something very bad results, whereas the great opportunity for increased profits lies in making a corrective treatment while the trees are in condition to respond to it quickly and effectively.

The fact of the continued increase in the acidity of the soil, excepting where lime is naturally present in abundance, should be brought most forcibly to the attention of every grower of peaches. This is especially true where peaches are being grown on light, sandy soils, for these are usually poorly buffered against an increase in acidity.

Lime Situation in Apple Orchards

What has been said of the effect of the use of sulphur in peach orchards holds true to a considerable extent of apple orchards. Apple trees, however, are doubtless less af-

fected by a definite degree of acidity than peach trees, and furthermore they are usually planted in heavier and better buffered soils, so the possibilities by way of improving the yield and quality of the fruit are more remote than in the case of the peach. The gain is related, however, very closely to the growth of the grass and associated herbage, or to the various cover crops that may be grown to increase the supply of humus.

The apple-orchard studies at the Pennsylvania State College have brought out in the strongest light the effect of neglecting for a long term of years the addition of organic matter to the soil. When a serious situation of this kind develops with middle-aged trees they are being hampered by bad conditions just at the time when they should be capable of yielding their largest financial returns. Unfortunately, also, it takes several years to build up a soil condition that will carry an orchard safely through this critical period. In the case of early and long continued neglect the trees finally shade the ground to such an extent that grass or cover-crop growth is seriously handicapped, and recovery is slow and difficult. The proper course, therefore, is to use enough lime to offset the acidifying effect of the annual sulphur treatments so as to insure an adequate quantity of mulching material or ample amounts of cover crops. These will then maintain orchards in condition to respond in yield to the fullest extent at and during the time of their natural greatest productiveness. The best course to follow is to make occasional small applications of lime rather than to apply large amounts at a time. With a proper soil-testing outfit it is possible to check frequently the chemical reaction of the soil, so that the development of an injurious degree of acidity can be avoided.

The importance of the maintenance of an abundant supply of organic matter in orchard soils, and the relation of lime to its accomplishment, should be brought home to every apple grower in the country who is not growing his trees on a calcareous soil.

Need of Lime for Plums and Cherries

While I was experimenting in Rhode Island with various kinds of trees in order to ascertain their response to lime under varying degrees of soil acidity, I was visited by the well-known horticulturist, J. W. Powell, of New York. In the course of our preliminary conversation he said he wished I would tell him what was the trouble with a Japanese plum orchard that he had planted, in which the trees were not growing as they should. I told him if he would wait a while he might get his answer direct from some plum trees on the experimental plots. Before he had completed his examination of the trees where sodium nitrate and ammonium sulphate had been used with and without lime, he admitted that he had received the promised answer. They showed a remarkable increase in growth where lime was used, even in the case of the sodium nitrate. Similar striking benefit was noticed also in connection with the growth of the Early Richmond cherry and to a less extent in the sweet cherry (Black Tartarian).

Several years later I met Mr. Powell in New York. He came up, grasped me heartily by the hand, and thanked me for saving his plum orchard. He said that after the liming it came along in splendid shape and no further trouble was experienced.

No doubt the presence of lime in the soils was an important reason for the excellent growth of cherries that I have observed in certain districts in Germany. The successful sour-cherry district not far from Green Bay, Wis., is underlaid by limestone generally within 18 in. to 3 ft. of the surface of the ground, which insures an abundant supply of lime to the roots.

We now know that by liming and suitable fertilization it is possible to grow the plum, cherry and quince wherever the climatic and soil conditions are suitable.

Nurserymen Should Be Interested

While it is true that many of the evergreens, rhododendrons, azaleas, and in fact most or all members of the *Ericaceae* family of plants are readily injured by lime, many of the shrubs and trees used for ornamental planting respond to its use. A notable example is the American elm, which is benefited probably far more than the sugar maple, whereas the gray birch will possibly do as well or better without it. The Rhode Island Agricultural Experiment Station is now making experiments in this line with a considerable number of ornamental shrubs in order to get a better idea of their lime requirements.

The man who now makes plantings of the American elm will use both lime and fertilizer where he wishes the quickest and most vigorous growth.

Effect of Lime on the Physical Soil Condition

Several years ago while on a visit to the Agricultural Experiment Station at Poppelsdorf, near Bonn, Germany, my attention was called to the fact that where sodium nitrate had beeen used as a source of nitrogen for several years on a clayey soil it baked so badly that it was almost impossible to work it. Liming, however, corrected the condition satisfactorily. Several years ago a similar case of bad physical condition of a Virginia soil was brought to my attention and the recommendation to apply hydrated or burned lime was followed with complete success.

One of the most striking studies of the effect of lime upon the physical condition of the soil is that made at the world-famous Rothamsted Experimental Station, England, where it was ascertained, by the use of a dynamometer, that the draft was reduced one-sixth and the soil could be plowed 26% faster where lime had been used.

At the Rhode Island Agricultural Experiment Station the limed plots dried out so much earlier than the others, in the spring, that the land could be worked from a week to ten days earlier. When the surface of the limed plots was dry the others still presented a wet, slick appearance.

At the Lime Conference held in Knoxville, Tenn., in 1930, Young, of the Tennessee Station, mentioned the fact that, so far as the surface soil was concerned, the limed plots at that station appeared dry in the spring, while the unlimed areas still appeared "wet and muddy." At the same conference, Conner, of the Indiana Station, mentioned the beneficial effect of lime on winter wheat due to its lessening injury caused by heaving of the soil during the winter and spring months.

This physical, or flocculating, effect of lime is often of great importance to the practical farmer who usually finds himself pressed for time in the spring, and the advantage is great if he can begin to work his land a week to ten days earlier. Where spring grains are grown another distinct advantage may arise from being able to sow the grain earlier, for every grain grower knows that if he can sow it a week earlier it often means that it will fill out and ripen before the advent of extremely hot weather. This results in a heavier yield of plump, high-quality grain.

There have been instances in the past where some over-zealous salesmen have tried to make farmers believe that if they would apply lime it would not be necessary to use fertilizer. This, however, is one of the most serious mistakes that could be made. On the other hand, one occasionally hears it stated that "lime is not a plant food." This is an equally mistaken notion, for lime is just as essential to plant growth as is any one of the usual fertilizer ingredients. While it is true that usually the chief function of lime is as a soil neutralizer, it unquestionably functions in many cases as a direct plant food. This is most likely to be the case with clover, alfalfa, sweet clover and other plants that are particularly rich in lime.

Aside from its physical effect on soils, and in addition to its promotion of ammonification and nitrification, lime aids free-living bacteria to fix nitrogen in the soil and also aids many of those that are responsible for the fixation and assimilation of atmospheric nitrogen by certain of the legumes. In many cases these benefits are far outweighed by the fact that the lime creates such a favorable soil condition for the plant that it can make a far better use of the fertilizer provided for it than would otherwise be possible. I have known many a case where by using both lime and fertilizer on a single acre a much greater and better crop was secured than on two acres when one was merely limed and the other merely fertilized.

Some Effects of Lime on Plant Diseases

It is perhaps just as important from the standpoint of lime manufacturers to prevent

the improper and excessive use of lime as it is to promote its correct and effective employment, for one talkative knocker against lime can neutralize the effect of a dozen boosters. A salesman who is recommending the use of lime to farmers should understand not only its effect on ammonification, nitrification and soil flocculation, for example, but should also know its effect upon plant diseases. He should know that heavy liming is one of the best preventives or remedies for the finger-and-toe, or clubfoot, disease of the cabbage, cauliflower and related plants. He should know to what limit curative methods can be used and what the consequences are of carrying the treatment to extremes. He should likewise know that the moderate use of lime from the outset is a far better practice than early neglect and a later attempted cure.

Common potato scab serves as an illustration of the reverse of conditions and treatment, for by our work at the Rhode Island Agricultural Experiment Station it was shown that if the causative organism is present in the soil or on the "seed" potatoes the disease is greatly promoted by a slightly acid, neutral, or alkaline soil. In recognition of the fact that an acid condition is less conducive to the development of potato scab, many growers have resorted to the use of sulphur, which, through oxidation by means of the sulphofying organisms of the soil, is changed into sulphuric acid. This, like many other excellent treatments, has often been carried too far, with the result that serious injury to potato plants has developed. In severe cases the lower leaves become yellowish or blanched, and I have seen instances on Long Island where the injury thus brought about was so great that entire fields of potatoes had to be plowed under.

Much valuable and interesting work in this connection has been done by Wessels, a former assistant at the Rhode Island Station, now in charge of the Riverhead, L. I., branch of the New York (Geneva) Station. In general, it has been found that to escape serious development of potato scab, where the soil is already contaminated or where the tubers that are planted carry the scab germs, the pH value of the soil should seldom be higher than 5.2 to 5.3. It is equally important that a degree of acidity much greater than is represented by a pH value of 4.8 should be avoided, for if it drops to 4.5 to 4.3 the total yield of potatoes is likely to be greatly decreased, but more particularly the yield of potatoes of marketable size, and there will be a marked increase in very small or "cull" potatoes.

All along the Atlantic Seaboard, and rather generally in the Coastal Plain district of the East, soils are frequently met with that are so acid that commercially successful crops of beets, spinach, lettuce, cantaloupe, cabbage and cauliflower cannot be grown without the use of lime. Yet the Rhode Island Station and the Virginia Truck Experiment Station have found that while the use of lime is essential to success with spinach, too large an application may result in a yellowing, or chlorosis, of the plants. Two or three years ago I visited two spinach fields on Long Island on the same day. On each so much lime had been used that the pH value of the soil had been brought up to 7.4, or decidedly on the alkaline side (neutral being 7). In one case the crop was a successful one, whereas in the other case the plants were so generally and completely yellowed that they had to be plowed under. Upon investigation it was found that the first farmer had used, frequently, large applications of manure, and the soil gave evidence of being in good physical condition. In the case where the plants had turned yellow, little or no manure had been applied in recent years, and the physical condition of the soil was distinctly bad.

In order to better understand the situation it should be explained that the yellowing of spinach leaves that had been observed at the Rhode Island Station, where the soil had been too heavily limed, was in consequence of the lime having rendered the manganese of the soil so insoluble that the plants could no longer get enough of it. This was proved beyond question by the fact that upon repeated spraying with manganese sulphate the condition was cured. It was interesting to observe, in the case of the bad Long Island spinach field, that there was here and there an occasional spinach plant that was green and entirely devoid of yellow leaves. Wherever such plants were found the soil immediately about them was still slightly acid. This occurrence was doubtless due to the fact that the lime had not been distributed uniformly. On account of the great lack of organic matter and of the poorly buffered condition of the soil, the lime in this case, as might have been expected, had a bad effect. Another factor that may have much to do with the result is the probability that where manure had been employed with considerable regularity, some manganese was added in the manure. Still another factor may have been the continual production of organic acids, as a result of the decomposition of the manure, which may have helped at times to keep manganese in solution and make it, therefore, more available to the plants.

Gile at the Porto Rico Station had a similar chlorotic effect on pineapples when he used a heavy application of lime, and this he succeeded in curing by repeated spraying with manganese salts. The cure no doubt suggested itself to him, for the reason that in the Sandwich Islands pineapple plants that would have failed on account of taking up too much manganese were cured and made successful, in a large commercial way, by spraying them with an iron salt.

Those familiar with the soil conditions in Texas are aware that successive cotton growing is an economic impossibility in certain sections where the soil is well supplied with lime, for the reason that the lime favors the development of cotton root-rot. Obviously, therefore, care must be taken not to use too much lime where cotton is to be grown, provided the organism is present that gives rise to the root-rot, or in case its introduction is likely to occur.

On very acid soils tobacco will not make its best growth, and when grown under such conditions so little lime is often taken up and either so much iron or so much iron and manganese enter the plant that the ash, instead of being white or grayish, may have a distinct reddish or brownish hue. On the other hand, lime has been found conducive to the development of the black root-rot of tobacco, hence care must be taken not to use too much. Recently Truog and his associates at the Wisconsin experiment station have shown that another kind of root-rot often develops when the young tobacco plants are not getting a liberal supply of nitrogen in nitrate form. Under such circumstances the causative organisms failing to find enough nitrate nitrogen in the soil for their use begin to take nitrogen out of the tobacco roots, thus giving rise to what is known as "brown" root-rot of tobacco. Where such extreme conditions prevail, the presence of a small amount of lime would have a tendency to promote more rapid nitrification and should therefore help to prevent the development of the difficulty. This may explain why fields affected one year may be free from brown root-rot the following season. From the foregoing it will be seen that there is a happy medium that should be maintained if one would escape the danger of both extremes.

Anderson, of the Connecticut Tobacco Experiment station, says they have much black root-rot where the soils reach a pH value of 6.2. In some cases the uppermost limit that can be reached with safety is pH 6 and in others it may be necessary to hold the soil down to practically pH 5.6. Such limits can not always be placed as closely as might be desired, because the pH value varies in the same soil at different seasons. Morgan, of the Connecticut Station, in speaking of the "Frenching" of tobacco in his state, says that most of that form of chlorosis occurs at pH values above 6.7. A similar relationship of lime to frenching is also reported by Willis in North Carolina.

In regard to cowpeas, McCall reports experiments conducted at the Arlington farm near Washington, D. C., in connection with which a soil was used having a natural pH value of 4.8. In one case enough lime was added in hydrated form to create a pH value of 6.8 and in the other case a pH value of 7.5. On the natural soil there was no evidence of disease, but in both the other cases the plants were severely attacked by mildew. It has been said that similar observations have been made by McHargue in Kentucky. Whether mildew is caused by a change in the pH value of the sap of the plant, as a result of liming, remains to be ascertained. In any event, some change in the cowpea

plant was brought about which rendered it more subject to attack by the fungus that causes the mildew.

Roberts, of Kentucky, states that when the pin oak is transferred from its native acid-soil habitat to soils containing much carbonate of lime, it fails to thrive as before, and in some cases loses some of its foliage. He reports that Dr. Valleau painted some of the leaves with salts of manganese and iron, and the latter caused their recovery. The affected leaves contained less manganese than the others and a slight deficiency of it may have existed, but the more serious lack brought about by the lime was that of iron. Similar ill effects of lime on the pin oak are also reported as occurring in nurseries and on lawns.

In striking contrast to the pin oak high acidity, represented by a pH value of 4.2, in Connecticut made the manganese in the soil so soluble and available to tobacco that the excess of it taken up caused chlorosis; just as too much lime causes chlorosis when the acidity is too much reduced and the pH value approaches 7. Anderson reports that he has observed similar conditions also in Cuba.

In speaking of muck soils, for onions, Conner, of Indiana, says: "I would rather farm a muck soil that is half saturated with calcium than one fully saturated." He says they "have more trouble with muck soils that contain free calcium carbonate than with any others, except very acid ones. Onions will not tolerate alkaline conditions and OH ions are possibly more injurious than H (acid) ions." This is in accord with the work of Hartwell and his associates in Rhode Island, who found that excessive liming brought about a form of chlorosis in the onion that they were able to cure by spraying with manganese sulphate.

Corn root-rot, according to Conner, is common on the calcareous soils of northern Indiana, and, he says, "The lime question is tied up with root-rot in corn." For that reason he holds that corn soils should be kept under the saturation point for lime, and they must not be over-saturated. At the Rhode Island Station heavy liming was disastrous to corn, beets and several other crops, although not always in the same degree as for spinach and onions.

French writers mention a chlorosis of grapevines as due to an excess of lime and other unfavorable condtions.

Chlorosis is a frequent occurrence in *Citrus* in Florida where outcrops of marl occur; and Wallace (E.S.R. **64**, [1931] 450; also E.S.R. **57**, p. 750) mentions the development of chlorosis of fruit trees on calcareous soils. A cure, under such conditions, by the use of iron salts is described by the California experiment station. Korstian, Hartly, Watts and Hahn (*Jour. Agr. Sci.* **21**, [1921] 153-71) give a cure for chlorosis effected by the use of a 1% solution of iron sulphate, in the case of both the Yellow and Jack pine; and they add that irrigation waters carrying lime increase the difficulty.

In regard to chlorosis in rice, Metzger and Jansson (*Jour. Agr. Res.* **37**, [1928] 589-62) say that it did not develop until the soil reached a pH value of 6, and where there was plenty of organic matter it did not develop until a pH value of 7 was reached. This they attribute to the buffering effect that organic matter is known to exert.

Deutsch and Steinfatt report that alkaline soils and applications of calcium carbonate give rise to a disease of lupines.

In Europe a disease of oats known by the Germans as "Dörrfleckenkrankheit" and by the Dutch as "Haferziekte" has been found to occur in case the fields are over-limed, and I have noticed the same thing also in Rhode Island. Since this disease has been cured by the use of a manganese salt, it is supposed that too much lime renders the manganese in the soil so insoluble that the oat plants fail to take up the needed amount. Some authorities claim that for oats the chemical reaction of the soil should usually be maintained between pH 6 and pH 6.5, but that the range may be higher in a dry than in a wet year.

According to P. E. Turner (*Jour. Agr. Sci.* **19**, [1929] 26-35), if lime is deficient in sugar-cane soils, injury to the cane from blight, caused primarily by "froghopper" (*Monecphora saccharina*), is much greater than otherwise. Arrhenius says the optimum pH value for cane is about 7. When this was exceeded production dropped off rapidly, but it decreased more slowly with an increase of the soil acidity.

Sherbakoff reports having examined thousands of acres of bananas and wherever the pH value of the soil was "noticeably above 6.2 there was no significant danger from wilt, no matter how long the bananas were grown in that soil. However, on soils with pH below 6 there seems to be always very serious danger from wilt."

A study has been made of the rate of development of corn roots at different pH values. In eight days it was 6.2 m.m, at pH 4; 17 m.m, at pH 6.8; and 12 m.m, at pH 8.4. At the North Carolina Experiment Station corn root-rot was increased up to 75% by liming, but when potash was also used it was reduced to 10%, and without either lime or potash it was 15%. This interesting observation probably finds its explanation by German reports, substantiated in this country by McIntire, to the effect that lime in some way often makes the potash in the soil somewhat less available to the plant than before. Therefore, where lime has been applied it may be necessary to use a fertilizer carrying a higher percentage of potash than would otherwise have been required. Possibly this may be due to the formation of double silicates of lime and potash in the soil, in which form the potash is less readily taken up by plants than before. This might be termed a combined fixation-mineralization process.

The foregoing illustrations show that lime should be used with understanding and care, not only because of its chemical and physical effect on soils, but perhaps more particularly because of its effect upon the development of plant diseases; and, in some cases, upon insect life on account of the relation of insect injury to the development of plant diseases.

More General Use of Acid-Reacting Fertilizers Increases the Need for Lime

In recent years the abundant production of ammonium sulphate and its relatively low cost have caused it to be used in fertilizers to a far greater extent than ever before. As a result, the need of lime has increased at a more rapid rate than would have been the case if potassium nitrate and sodium nitrate had been used in increasing proportions in fertilizers. As far as concerns calcium nitrate, its extended use would tend to lessen the development of a dangerous degree of soil acidity, but its deliquescent property prevents its use to any considerable extent in "complete" commercial fertilizers. Very recently the former extreme tendency toward acidity in fertilizers has been materially lessened by the direct introduction of hydrous and anhydrous ammonia into superphosphates and fertilizer mixtures. However, ammonia, urea and organic forms of nitrogen, such as blood, meat, fish, and similar materials, all have a tendency in the same direction. While this may be fortunate or unfortunate from the farmer's standpoint, depending upon his soil reaction and the crops he wishes to grow, it has added to the business of the lime manufacturer.

What Can Be Done to Ensure a Greater Use of Lime Where It Is Needed?

Perhaps all has been accomplished that is possible at this time by the issuance of bulletins and circulars on the general subject of lime and its use. However, farmers are born every day and the work of education must be repeated. What is needed is a closer and more direct contact with the farmers than is possible by such means alone. Much can be accomplished by holding meetings where soils are tested free, where short snappy talks are given on lime and its use, where the question-box is made a prominent feature, and where a special effort is made to get farmers who have used lime successfully to stand up and tell, briefly, what they have done.

Nothing, however, is so convincing to the average farmer as what he can see, with his own eyes, on his own or his neighbor's farm. In other words, the most convincing evidence is that afforded by an actual demonstration. Just as soon, however, as the idea of a demonstration is mentioned someone is likely to kill it at birth by insisting that if it is to be convincing to the farmer it must involve not less than an acre, or preferably several acres. Obviously the

profits from the sale of lime are so small that, on such a basis, the work is likely to be abandoned before it is begun, and the farmer is left in the same situation as before. As already mentioned, in connection with the efforts by the railroads, demonstrations by farmers have been sought through the donation of large amounts of lime to a few men in selected localities, but these efforts have often been costly in proportion to the benefits derived. Furthermore, at a time like this, when the railroads are suffering from a high wage scale and a minimum movement of freight and passengers, with some of their financial reports in the red, it may be difficult to secure the same degree of cooperation as in the past.

The hauling and dumping of occasional carloads of lime at railroad sidings to be hauled away and used by the farmer without charge is both expensive and inefficient, for the reason that many farmers who help themselves would never think of buying lime no matter how much they may need it. Furthermore, where it is used without guidance, or general supervision, lime may be applied in an improper manner, at the wrong stage of a crop rotation, or for a crop that either does not need it or that may be injured by it, especially if large amounts are used with a free hand. Such use of lime may produce more knockers than boosters.

It is generally conceded that one of the great deterrents to the wider use of lime is the fact that few farmers are in position, financially, to buy a carload at a time, or they may not have a sufficient acreage to justify such a procedure. Furthermore, it is often difficult to get several farmers to pool their orders and buy a full carload. Storage facilities, differences in the time when the different farmers wish to use it, provision for sure and prompt payment, and other handicaps often arise. In order to offset most of these difficulties, dealers have in some cases been induced to carry lime in stock, at a small profit, so that individual farmers can secure what they need on short notice. Where this has been done sales have usually shown a marked increase. The great difficulty is to convince the dealer that, despite small profits, the sale of lime is greatly to his advantage on account of its increasing the farmer's profit; thus bringing to the dealer a much larger volume of general trade.

It would unquestionably be in the dealer's interest to handle lime in much the same way that the groceryman handles, and profits indirectly from, the sale of sugar. This is a phase of the lime situation that should be driven home to every dealer who insists upon enjoying a scale of profit that makes the purchase of lime prohibitive, from the farmer's standpoint. The dealer who refuses to handle lime unless he makes a big profit from its sale is veritably killing "the goose that lays the golden egg." In cases where dealers have been persuaded that small profits and real service pay, the sale of lime for agricultural purposes has been greatly increased. This is because the farmer can get what he wants *when he actually needs it.*

I have often wondered if lime companies might not find it profitable, occasionally, to send men out to promote demonstrations when farmers are getting ready to plant, or at seasons when they are preparing to seed their land to alfalfa, sweet clover, or to clover and grass. If they could carry with them a supply of lime in 100-pound bags, in light trucks, it ought to be possible to find plenty of farmers who would buy a single bag and apply it on a few rows, or in narrow strips, extending back into the field as far as it would reach, at the rate desired.

Such trials might often be made where the results could be readily seen from the roadside or from a farm road—they would then be constantly in sight. My theory is that if the farmer buys the lime he will feel a keener interest in the outcome than he will if it is presented to him.

I am not speaking from theory regarding the utility of small-plot experiments and demonstrations, for while I was connected with the Rhode Island Agricultural Experiment Station I conducted small-scale experiments with lime in every township in the state, after first ascertaining who were the most up-to-date and progressive farmers in the town, for these men were ready in farmers' meetings to tell of the benefits observed. These trials were fully convincing, and they served their purpose well. I have also conducted small-area experiments of some kind in most of the eastern states, also in Michigan, Wisconsin and Minnesota; and there was no question about their convincing effect. Trials of materials in a way that involved large areas meet with the drawback of costs that often prove prohibitive.

It is hoped that someone will suggest a better way of leading the practical farmer to the use of lime than any heretofore employed, for we are all seeking the most economical and practical means of showing him how he can add to his profits. By such means, the lime industry will be doing itself the best possible service.

Masonry, Natural, and Pozzuolan Cement in 1931

HYDRAULIC CEMENTS other than portland cement, which include natural and pozzuolan cements and masonry cements of the natural cement class, produced in the United States in 1931 amounted to 1,241,803 bbl., which represents a decrease of 30.7% in comparison with 1930. In 1931 there were shipped from the mills 1,226,850 bbl. of these cements, valued at $1,619,920, a decrease of over 31.3% in quantity and of 34.4% in gross value as compared with 1930. Stocks at the mills increased and were 7.4% higher at the end of 1931 than at the end of 1930, an advance summary of the industry by the Bureau of Mines states.

These statistics represent the output of 12 plants, located as follows: One each in Illinois, Indiana, Kansas, Kentucky, Ohio and Pennsylvania, and two each in Alabama, Minnesota and New York. In addition to the 11 plants that reported output in 1930, one plant located in Alabama reported the production of pozzuolan cement in 1931, and its output is included in the figures for that year.

The output has been expressed in terms of 376-lb. barrels to correspond with the statistics of portland cement.

MASONRY, NATURAL, AND POZZUOLAN CEMENTS PRODUCED, SHIPPED AND IN STOCK IN THE UNITED STATES, 1930 AND 1931

Year	Active plants	Production Barrels	Shipments Barrels	Shipments Value	Stocks Dec. 31 Barrels
1930	11	1,792,083	1,787,016	$2,469,531	*202,416
1931	12	1,241,803	1,226,850	1,619,920	217,369

*Revised.

Canadian Iron Oxides, 1931

SHIPMENTS of iron oxides from Canadian deposits during 1931 totaled 5520 short tons, valued at $49,205, according to finally revised statistics just issued by the Dominion Bureau of Statistics. Production in 1930 amounted to 6596 tons, worth $83,873. Shipments from properties in 1931 were confined to the provinces of Quebec and British Columbia; the Quebec output is consumed largely by the pigment industry, while that from the western province is used in the purification of artificial gas.

The Quebec Department of Mines recently investigated the ochre deposits at Little Romaine and Bergeronnes, situated on the north shore of the St. Lawrence river. The Romaine ochre area measures 400 ft. by 1500 ft., and 113 samples show an average depth of 1 ft. and an average tenor of 86.88% Fe_2O_3. The ochre is of different colors and grades, yellow or brown at the surface and gray at depth. Forty drill holes on the Bergeronnes deposit established an average depth of 15 in. and a mean tenor of 91.2% Fe_2O_3. The mineral in this deposit occurs as disconnected pockets.

Booklet on Hoover Dam

THE second of a series of booklets describing work at the Hoover Dam has been issued by the Ingersoll-Rand Co.

Consisting of 40 pages and 85 illustrations, Volume 2 describes the building of Boulder City and the driving of the four 50-ft. diversion tunnels. These booklets, under the title "The Story of the Hoover Dam," may be obtained from any of the company's offices.

Methods and Costs of Mining and Crushing Gypsum at the Mine of the Blue Diamond Corporation Ltd., Arden, Nev.*

By W. G. Bradley†

Production Manager, Blue Diamond Corp., Ltd.

THIS PAPER describing the quarrying, mining, and crushing of gypsum at the Blue Diamond mine, 11 miles from Arden, Nev., on the Union Pacific Railway, is one of a series on gypsum mining being prepared for and published by the Bureau of Mines.

These papers are designed to disseminate technical information regarding the methods used. The cost tabulations represent operating expenditures only and not total costs. It is recognized that publication of total production costs might in some instances cause embarrassment to individual producers as well as to the industry as a whole. On the other hand, operating costs are essential to the technical discussion and study of the methods employed. The attention of the reader is specifically called to this differentiation in order that no misunderstanding of the scope of the cost tabulations shall ensue.

The author wishes to acknowledge the assistance of I. E. King, mining engineer and superintendent of the mine, in the preparation of this paper.

History

The gypsum property at Arden was first investigated in the spring of 1923, but owing to its great distance from the markets in California and the difficulties and expense connected with its development, actual work did not start until January, 1925. During the interim, many other properties were inspected but none was found that showed such a high quality or such an abundance of ore. As the gypsum deposit was situated on a mountain top, access to which was by foot only, there was much preliminary work necessary before actual plant construction was begun. Before production started it was necessary to build 11 miles of standard-gage railway to connect the property with the main line of the Union Pacific, and 1 mile of aerial tramway to transport the ore down to the railway. It was also necessary to build 8 miles of truck road in order to bring in crushing and power equipment and camp supplies.

The property contains approximately 1000 acres, of which about one-third is covered by the gypsum deposit.

Geology

White, massive gypsum occurs here in the Red Bed formation, which is thought to be of the Traissic period. The deposit is of sedimentary origin and varies from 12 to 20 ft. in thickness. It has a slight dip to the west, and is capped by strata of red clay, sandstone, and two irregular beds of gypsum, and in places by broken limestone. The thickness of the capping rarely exceeds 100 ft., and where it does, the gypsum bed is usually more or less anhydrous. Directly overlying the gypsum bed is a 2-ft. stratum of mixed clay and gypsum which has great strength and permits an open system of room and pillar mining to be followed. See Fig. 1.

The footwall is a limestone stratum and the parting between both the floor and capping is smooth and separates readily from the gypsum.

There is a fault on the west side of the property, which indicates that the formation there has been lowered and possibly eroded away. On the eastern boundary the formation is regular, but all of the gypsum beds and part of the limestone footwall have been removed by erosion.

The first exploration work was by means of trenches and open pits dug by hand along the edges of the deposit. It has since been found that drilling holes with a jackhammer run by a small portable air compressor is more economical and as accurate as trench methods for determining the thickness and grade of the gypum bed. One and one-half inch holes up to 20 ft. deep are drilled and cost on an average about 11 cents per foot.

The gypsum analyzes as follows:

	Per cent
$CaSO_4$	78.43
SiO_2	.65
$MgCO_3$	.25
Al_2O_3, Fe_2O_3	.02
H_2O	20.65

Due to the excellent grade of the gypsum, it is not necessary to use any form of concentration other than a little hand sorting

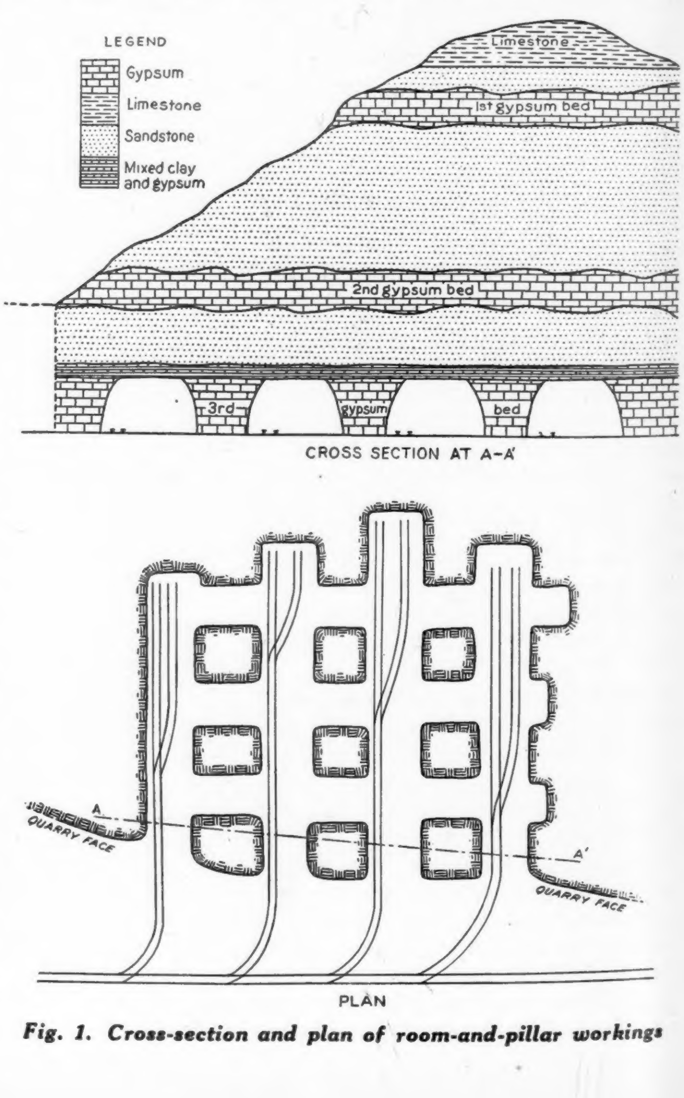


Fig. 1. Cross-section and plan of room-and-pillar workings

*Reprinted from U. S. Bureau of Mines Information Circular 6615.

†One of the consulting engineers, U. S. Bureau of Mines.

DESCRIPTION OF EXPLOSIVES USED IN MINING OPERATIONS

Commodity	Grade	Velocity	Size	Packing	Use
Gelatin, Ex. L. F.	30%	10,800 ft. per second	1⅛x8 in.	105 sticks in 50-lb. case	Primers, blasting boulders, hard rock
Gelamite	No. 2	11,090 ft. per second	1⅛x8 in.	140 sticks in 50-lb. case	Limestone, anhydrite, hard rock
Hercomite	No. 6	7,900 ft. per second	1⅛x8 in.	200 sticks in 50-lb. case	Quarry, primary blasting underground, all gypsum
Black blasting powder	FF	3,700 ft. per second	....	1 can of 25 lb.	Primary blasting in quarry, large shots
Sequoia fuse	....	1.5 ft. per minute	....	3000 ft. in roll	Secondary blasting in quarry, underground exclusively
Electric detonator	No. 8	Instantaneous	20-ft. wire	250 in box	Primary blasting in quarry
Detonator	No. 8	Instantaneous	....	100 in box	Secondary blasting in quarry, underground exclusively

to remove an occasional piece of overburden or, where mining has been too deep, a little limestone. The commercial gypsum is readily separated from anhydrous material, due to differences in hardness, texture, and color.

In places erosion has removed most of the overburden and where it does not exceed the thickness of the gypsum the overburden is loosened by blasting and removed with a ¾-yd. Osgood gasoline shovel. Where the overburden exceeds the thickness of the gypsum, the latter is mined by an underground room-and-pillar method.

Stripping

The overburden has no commercial value and is removed as economically and as cleanly as possible. This is done, as stated, by a ¾-yd. shovel, which, where the overburden is thick, casts it into the excavated pit, but where the overburden is shallow and covers a large area drags it away to temporary piles by using a heavy scraper attachment similar to a Fresno scraper in place of the dipper. From these piles the overburden is loaded to trucks by the dipper-equipped shovel. The scraping does not require any labor other than that of the shovel operator. When neither of these methods is able to reach past the working face, the shovel is used to load a 5-yd. dump truck, which hauls the material to any convenient site. The removal of overburden is more or less intermittent, since the shovel is able to strip

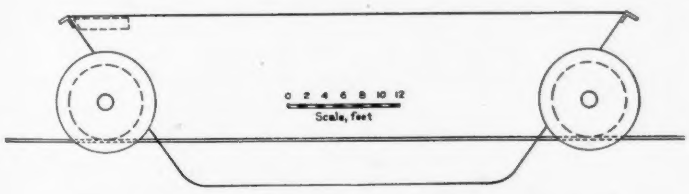


Fig. 4. Side view of 18-cu. ft., 4-wheel tram car

overburden much faster than gypsum can be mined; however, the stripping does not cover a large area but closely precedes the mining, since it would be necessary to rehandle or haul most of the material if a wide area was cleared.

No accurate figures have been kept, but it may be said that the ratio of gypsum to waste or overburden is roughly 3 to 1.

Mining

All open-quarry work is done by a bench method. A space approximately 20 ft. wide and 100 ft. long is cleared of surface material, drilled, and blasted. Gypsum in the solid weighs approximately 144 lb. per cu. ft. Thus, since the ledge on the average working face is about 16 ft. thick, a block of ground of the size indicated will contain about 2300 tons, practically all of which will be recovered. A large portion of this material will require some blockholing or secondary shooting to reduce it to a size that can be conveniently handled. It is then loaded by hand into the quarry cars to be taken to the plant.

Drilling and Blasting

Drilling and blasting for both overburden and gypsum are practically the same except that holes in the overburden are not spaced as closely as in the gypsum because fragmentation is not necessary. The holes in the overburden, however, are loaded with a greater percentage of black powder.

All drilling is done with jackhammers. These machines are light, fast drilling, and have excellent rotating mechanisms. Air is supplied at 95 lb. pressure. The drill steel is 1-in. hollow hexagon with hand-forged cross bits of 1¼- to 2-in. gage.

With these machines and the small steel it is possible to drill as much as 50 ft. an hour; however, the average for an 8-hour day is about ten 15- or 16-ft. holes. Spacing of the holes depends on their depth and on structural irregularities, but usually the burden at the bottom of the hole is equal to two-thirds its depth and the holes are spaced at a distance equal to one-half the depth. (See Fig. 2.).

Before blasting, the holes are sprung twice with 30% gelatin dynamite in 1⅛- by 8-in. sticks. Five sticks are used for the first springing and eight or nine for the second. Twenty-four hours is allowed for cooling after each springing. The holes are then loaded with 25 to 30 lb. of black powder in the pocket and 10 to 20 sticks of Hercomite No. 6, 1⅛- by 8-in. sticks in the column. A No. 8, 20-ft. wire, instantaneous electric detonator is placed in a stick of 30% gelatin dynamite for a primer and this is placed in the center of the pocket. Damp gypsum dust is used for tamping. Up

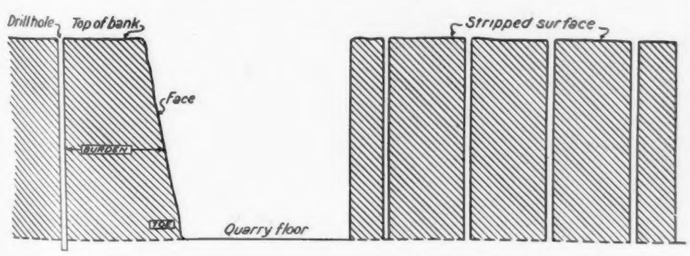


Fig. 2. Cross-section of quarry showing drill holes

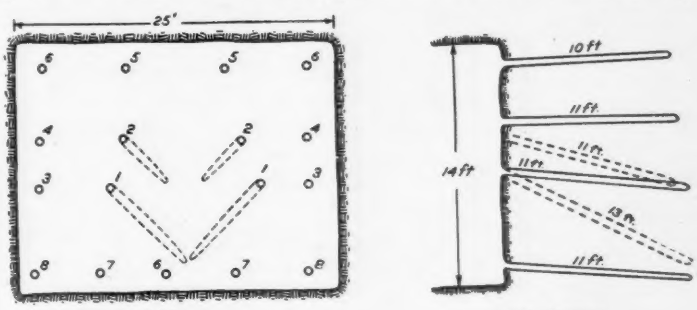


Fig. 3. Plan of drill round for drawing headings

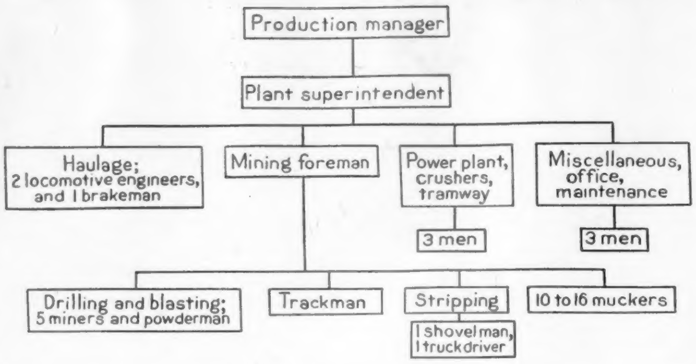


Fig. 10. Organization chart

to 25 holes, usually wired in series, are shot at one time from either a high-voltage magneto or a power line.

In secondary blasting, boulders over 3 ft. in diameter are drilled to the center and loaded with a small amount of 30% gelatin dynamite, which is detonated with a fuse and a No. 8 detonator. Stones less than 3 ft. but more than 2 ft. in diameter are broken by hand, using a 10-lb. rock hammer.

In primary blasting, an average of ¼ lb. of explosive is used per ton of gypsum. In secondary blasting, about half that amount is used.

The muckers are able to load an average of 20 tons each of broken gypsum in eight hours.

Haulage

The track is 42-in. gage and on the main line is laid with 45-lb. rail. Spur tracks of 30-lb. rail are laid parallel with and 10 to 16 ft. from the working face. These spurs can easily be barred closer as the work advances, and they make an excellent track due to the heavy ties which are 6 by 8 in. untreated pine timber 6 ft. long and spacd 2½ ft. apart. Side tracks of the same construction with a capacity of 10 cars are placed on each spur and within 100 ft. of the face in order that as little time as possible may be lost in moving out loads and switching in empties. The special low-built, automatic, bottom-dump quarry cars of 2½-tons capacity are handled entirely by locomotives, as they are too heavy to be moved conveniently by hand. Seven cars comprise a train that is hauled by a 4-ton Plymouth gasoline locomotive to the crushing plant, approximately 1000 ft. away.

Mining Underground

Underground mining is a continuation of the quarry work. Primary headings the height of the deposit and from 10 to 25 ft. wide, depending upon the local condition of the overburden and thickness of the ledge, are started at intervals of about 25 ft. (See Fig. 1.). As the headings are advanced, every alternate 20-ft. section on the sides is blasted to form transverse rooms. These rooms can be driven 15 ft. when using the haulage track for loading, but if it is necessary to go further than this, a switch is installed and track laid to the face. With the heading and the rooms open the miner always has two or more faces on which he can work, and in this way he may keep four or even eight muckers busy loading.

The pillars of the original mining amount to about 25% of the ledge and are left until the work has been completed. Then, starting at the back the pillars are cut down, and occasionally some are entirely removed, until only about 8% of the ledge is left, or what is absolutely necessary to hold up the overburden. To eliminate the danger of accidental caving, what is left of the pillars is drilled, loaded, and shot electrically to allow the overburden to settle. By this method about 92% of the gypsum is recovered.

Drilling is done with the same machines and steel as in quarry work. A typical round for drawing headings is shown in Fig. 3. The holes are loaded almost entirely with Hercomite. A stick of gelatin dynamite is placed midway in the hole for a primer and is fired with a fuse and a No. 8 detonator. As compared with the practice in quarry blasting the holes are closely spaced,

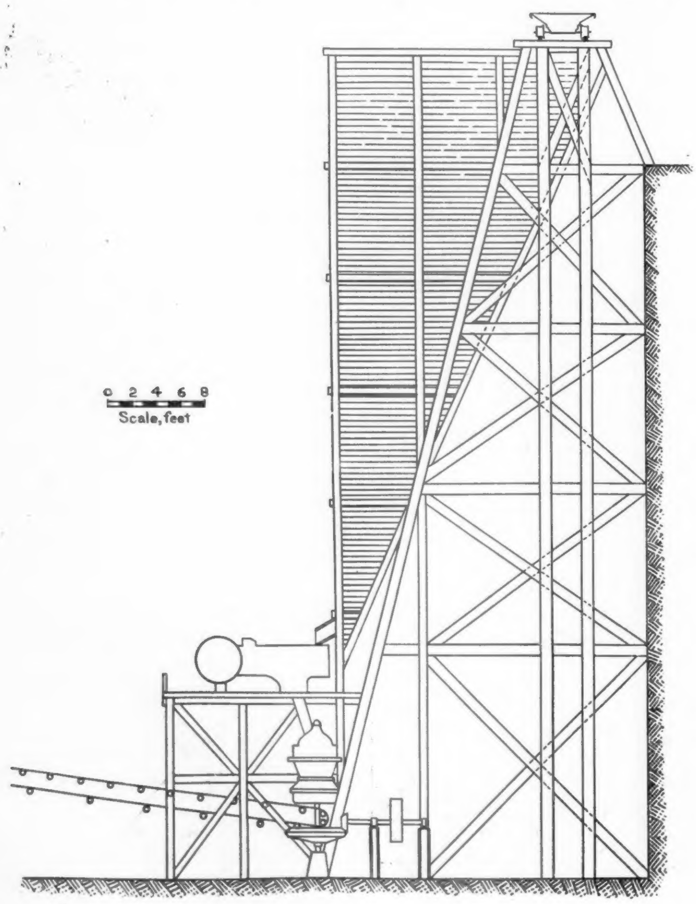


Fig. 5. Cross-section of storage bin and crushing plant

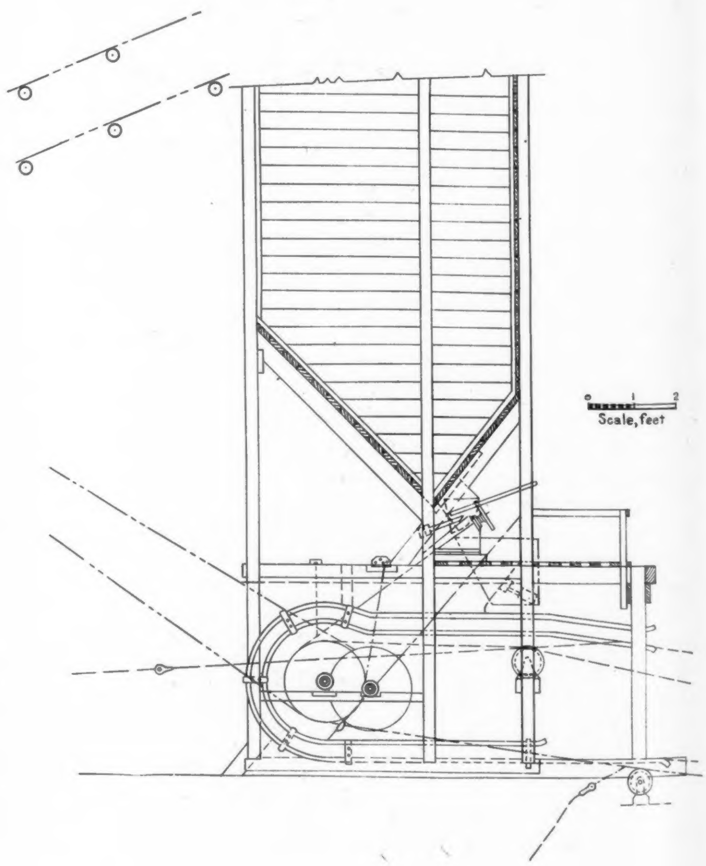


Fig. 6. Cross-section of bin and loading terminal

and little secondary blasting is necessary. A comparison of drilling and blasting in the quarry and underground is given in the following table:

	Quarry	Underground
Feet per round	......	8.5
Tons broken per foot drilled	3.68	1.14
Drilling cost per foot (cents)	4	4.9
Explosive per ton gypsum (pound)	⅜	½

The track system underground is more complex than in the quarry and must be kept at a minimum. Double track is placed in the headings of haulage ways and sometimes in crosscuts so that two cars may be loaded simultaneously at a working face. As the headings advance, the switches must be moved up closer. When the work has proceeded about 200 ft. in the various headings, one haulage way is used as a main line for a similar section further in. Thus a reduction in the amount of track increases the efficiency of the locomotive and provides longer periods for loading.

The accompanying table lists the explosives used in the various mining operations, both in the quarry and underground.

Crushing Plant and Tramway

Fig. 5 shows the crushing plant. The quarry cars are dumped into a 30-ton storage bin which has a grizzly bottom with ¾-in. openings for by-passing fines to a conveyor belt. From the bin the gypsum is fed by hand to a 24 by 34-in. jaw crusher which discharges minus 4-in. material directly into a 42-in. rotary crusher with a minimum opening of 1¼ in. The product here is roughly minus 1½ in. in size and is carried with the undersize from the bin grizzly on an 18-in. trough conveyor belt 60 ft. between centers, operating at 366 ft. per min. and with a rise of about 20 ft. to the tramway loading terminal storage bin, which has a capacity of about 100 tons (Fig. 6). This belt has an approximate life of 125,000 tons.

The tramway has a capacity of 50 tons per hour and consists of 11 steel towers (Fig. 7) supporting two sets of parallel track cables, one beneath the other. It is 3600 ft. long with a drop of 600 ft. and carries twenty-two 18-cu. ft. cars (Fig. 4). The tramway is operated by gravity, the loaded cars taking the top track, and the empties returning inverted on the lower one.

The cars travel 360 ft. per min. and theoretically when loaded generate about 14 hp. The cars are loaded from the crushed-rock bin at the head of the tramway (Fig. 6).

The tramway discharges to a set of stationary scalping screens (Fig. 8). The screens are so arranged that practically any division of sizing may be obtained or, if it is so desired, they may be bypassed by means of a gate and all material dropped directly into a hopper from which it may be loaded into standard railroad cars.

The screens are made from two pieces of wire cloth 4 ft. wide by 20 ft. long, spot-welded at the sides to a framework of ¼-in. steel plate 8 in. wide. These are held rigidly by welded cross rods at the top and bottom and rest on a timber frame at an angle of 48 deg. from the horizontal. The size of the screen openings which are most commonly used are as follows: for the top deck, 1 in. square opening with No. 8 wire; and for the lower deck ¼ in. square opening with No. 14 wire. Either the top or lower deck may be removed as a unit and another substituted. The life of the screens is estimated at three years. Hinged gates are used at the lower ends of the screens to regulate the distribution of the product.

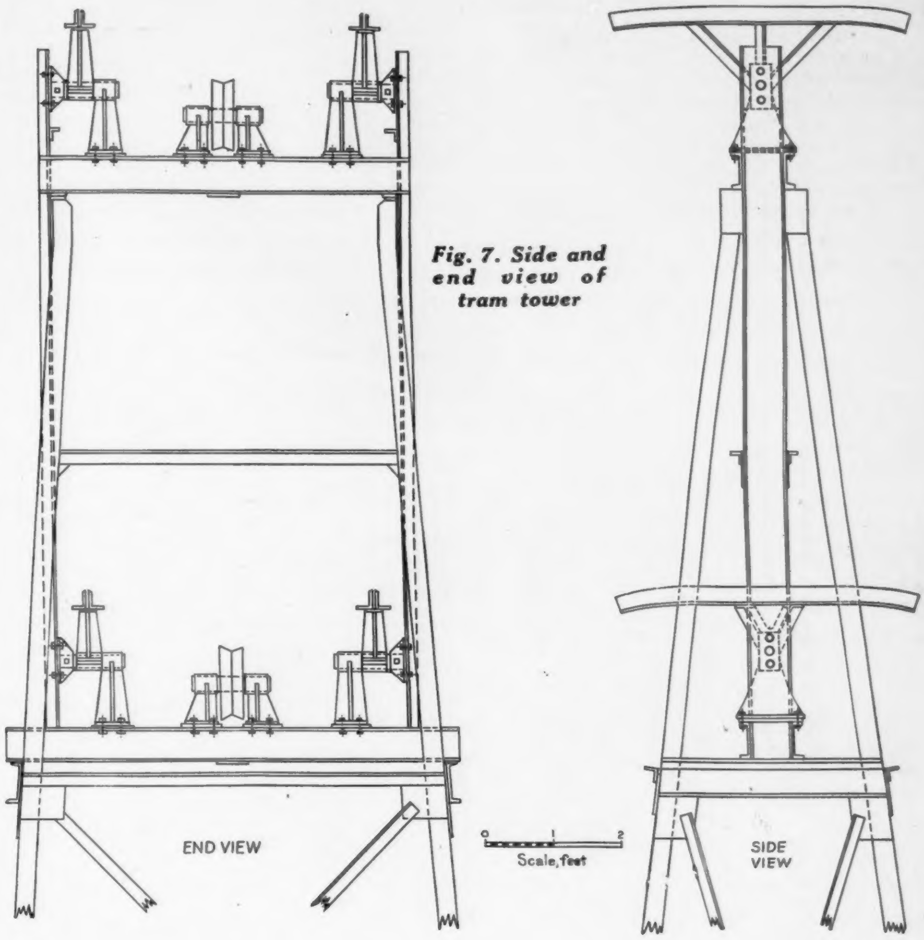


Fig. 7. Side and end view of tram tower

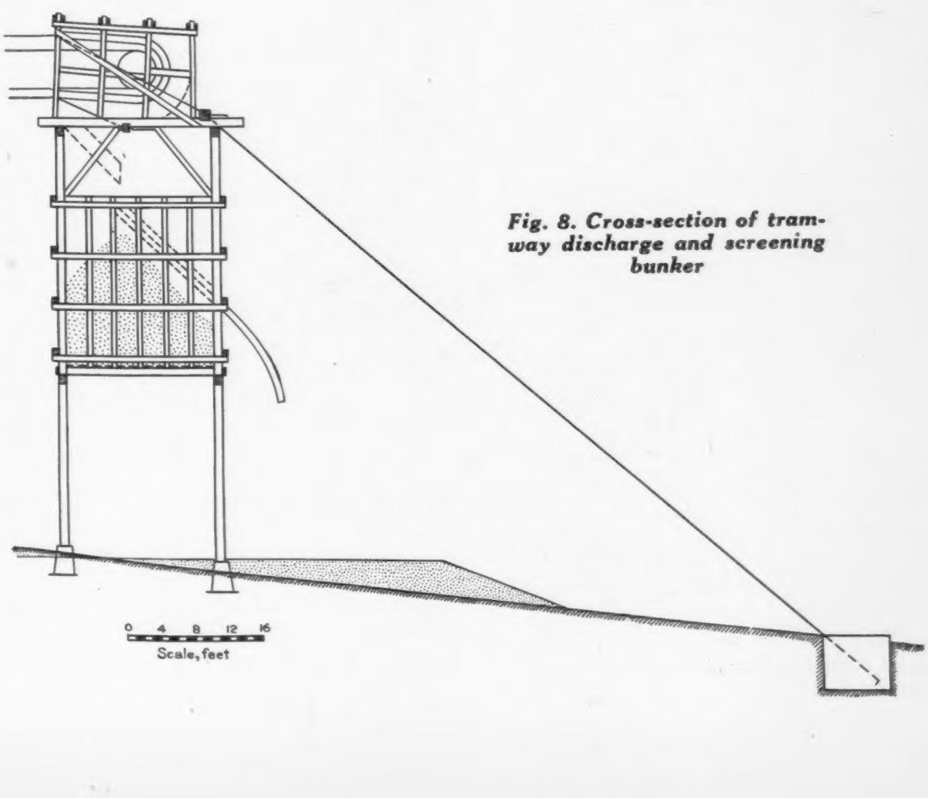


Fig. 8. Cross-section of tramway discharge and screening bunker

TABLE 1—SUMMARY OF COSTS

Period covered: January 1, 1930, to December 31, 1930.
Rock gypsum produced: 67,209 short tons.

	Labor	Superintendence	Power	Powder	Other supplies	Total
Operating costs:						
Drilling	$0.051	$0.008	$0.005	....	$0.006	$0.070
Blasting	0.009	0.002	....	$0.061	....	0.072
Loading	0.220	0.010	....	....	0.005	0.235
Haulage	0.054	0.006	0.008	....	0.015	0.083
Power plant	0.012	0.004	0.001	....	0.044	0.061
Crusher	0.027	0.004	0.004	....	0.008	0.043
Conveyor	0.003	0.001	....	....	0.003	0.007
Tramway	0.025	0.003	....	....	0.030	0.058
Screening and bunker	0.032	0.007	....	....	0.001	0.040
Track and pipe	0.043	0.006	....	....	0.031	0.080
Stripping waste	0.062	0.002	0.003	0.011	0.080	0.158
Miscellaneous	0.057	0.017	0.001	....	0.052	0.127
Total direct operating cost	$0.595	$0.070	$0.022	$0.072	$0.275	$1.034
Depreciation						$0.186
Depletion						0.050
Total operating cost						$1.270

The tramway is regulated and the power is supplied to the crushers, conveyor, and two 350 cu. ft. compressors by belts from a line shaft driven by a 180-hp., 3-cylinder, 14-in. bore, 17-in. stroke Fairbanks-Morse full Diesel engine. The fuel used in the Diesel engine is a fuel oil which costs $2 per bbl., delivered at the plant.

Fig. 9 is a flow sheet of the entire plant.

The wage scale is shown in the accompanying tabulation.

Normally, eight hours constitute a working day. The mine is operated six days per week and work is carried on continuously throughout the year.

A chart showing the organization is given in Fig. 10.

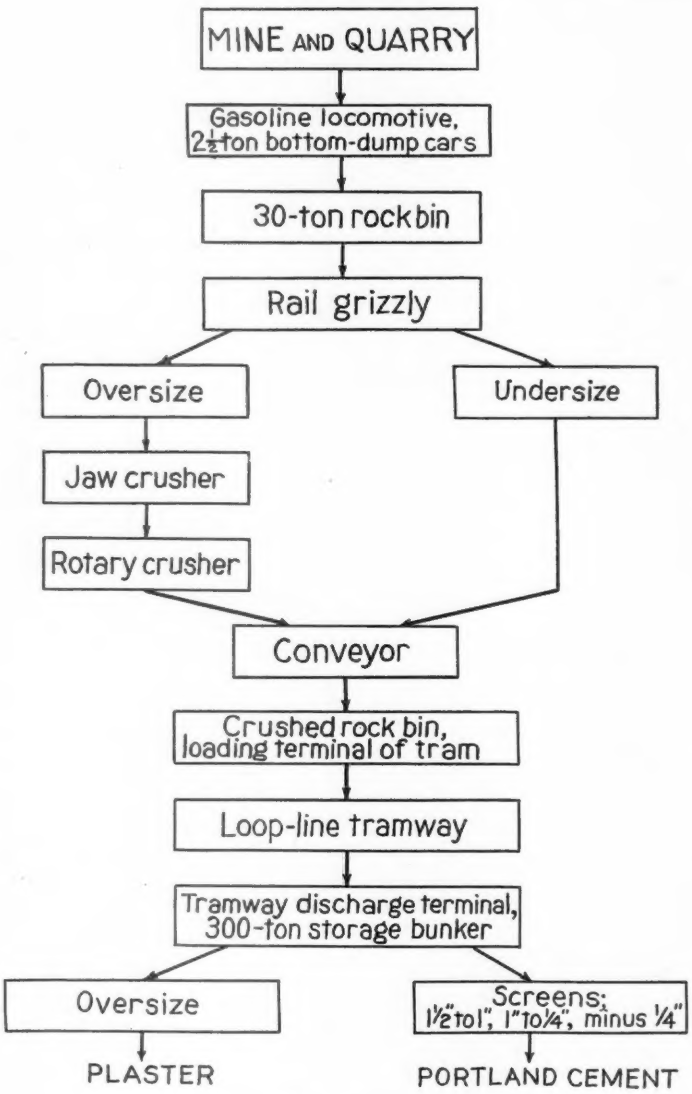


Fig. 9. Flow sheet of plant

First Aid

Both the superintendent and timekeeper have had some training in first aid, and a complete first-aid unit, including stretcher, bandages, antiseptics, etc., is kept on hand. By a contract arrangement a surgeon in a nearby town treats all employes for any serious accident or illness.

Mica in Canada in 1931

MICA PRODUCTION in Canada during 1931 was 1339 tons valued at $54,066 as compared with 1170 tons valued at $96,004 in 1930, according to final figures.

WAGE SCALE

Type of workman	Number employed	Wages per hour
Foreman	1	$0.78
Shovel operator	1	1.00
Powderman	1	0.75
Mechanic	2	0.75
Diesel engineer	1	0.70
Miners	3-5	0.65
Locomotive operators	2	0.65
Brakeman	1	0.625
Bunkerman	1	0.60
Truck driver	1	0.625
Muckers	10-16	0.50

TABLE 2—SUMMARY OF COSTS IN UNITS OF LABOR, POWER AND SUPPLIES DURING AN AVERAGE MONTH

A. Labor (man-hours per ton):

Drilling	0.09
Blasting	0.018
Loading	0.44
Haulage	0.10
Power plant	0.02
Crusher	0.04
Tramway	0.033
Screening and bunker	0.05
Track and pipe	0.066
Stripping waste	0.05
Miscellaneous	0.16
Average tons per man per shift	7
Percentage of total cost	63

B. Power and supplies:

	Pounds per ton	Cost per ton	Horsepower-hours per ton
1. Explosives	0.50	$0.072	......
2. Diesel	1.112	....	......
a. Compressor	....	0.00526	3.00
b. Conveyor..	....	0.00035	0.20
c. Crusher	....	0.00385	2.20
d. Miscellaneous (pumps, etc.)	....	0.00105	0.60
3. Locomotive	0.327	0.00835	2.00
4. Shovel	0.18	0.003	0.75

Cost of other supplies in percentage of total supplies and power 74

Supplies and power, percentage of total cost 37

Method of computing horsepower-hours and costs for power table:

Locomotive, 50 hp. for 8 hours	400 hp. hr.
10 gal. gasoline at $0.13	$1.30
½ gal. lubricating oil at $0.64	0.32
½ lb. grease at $0.10	0.05
	$1.67

200 tons per day—2 hp. hours per ton—$0.00835 cost per ton.

Fluorspar Milling

THE MILLING of fluorspar ores presents some problems in wet concentration not common to ordinary concentration practice. Edwin C. Reeder, manager, Hillside Fluorspar Mines, is the author of a publication by the United State Bureau of Mines, describing the methods used in the wet concentration of Illinois fluorspar. The report also covers costs of operation.

The process described involves close screening of the mill feed and treatment of the sized products over jigs, and tables.

Details of the operation are given in Information Circular 6621, "Milling Methods and Costs at the Hillside Fluorspar Mines, Rosiclare, Illinois," issued by the United States Bureau of Mines.

Barite and Barium Products in 1931

IN 1931 the crude barite industry in the United States was characterized by declines in total mine production, shipments, and prices, and an increase in total stocks at the mines. The total quantity of crude barite mined and sold in the United States, which has been annually more than 200,000 tons for the past six years (1925-1930, inc.), fell to about 174,500 tons in 1931, or about 26% below the corresponding figure for 1930. On the other hand, total imports of crude or unmanufactured barite for consumption in the United States in 1931 increased 40.2% in quantity, as compared with 1930. With the exception of 1929, imports in 1931 were higher than for any year for which imports of unmanufactured barite have been recorded, namely, 1884-1931, inclusive, an advance summary of the industry by the Bureau of Mines stated.

The total value of crude barite mined and sold in the United States in 1931 dropped to approximately $994,600. The total average value per ton was $5.70, or 85c a ton below that of 1930.

Barium Products Industry

In 1931 about 13% of the crude barite used in the manufacture of barium products and chemicals was ground and floated or otherwise refined and sold as such to manufacturers of chemicals, rubber and paper goods, linoleum, oilcloth, and other materials.

Manufacturers of lithopone in 1931 consumed about 59% of the quantity of crude barite used in the manufacture of barium products and chemicals. Lithopone is used extensively as a white pigment in flat and enamel wall paints for interior use.

Figures on the total quantity and value of barium binoxide sold or used by manufacturers in 1931 showed a slight increase in quantity as compared with 1930.

Barium carbonate, precipitated, which is used in the manufacture of other chemicals; in the ceramics industry for the manufacture of optical glass, and in the manufacture of wall paints and other materials, showed slight decreases in the quantity and value.

Barium chloride is used in the preparation of other barium salts, as a water softener, as a chemical reagent, and in other ways.

Barium oxide was manufactured for sale by two plants in 1931.

Barium sulphate, blanc fixe, or precipitated barium sulphate, was made in seven plants in 1931 (two more than in 1930). The total quantity manufactured and sold exceeded by far the quantity of any other barium chemical manufactured and sold during 1931, and the output showed increases in both quantity and value, as compared with 1930. Barium sulphate is used as a pigment or filler in the manufacture of paint and rubber goods, linoleum, oilcloth, glazed paper, and in the manufacture of other chemicals.

In 1931 the manufacture and sale of barium sulphide, the intermediate barium compound from which many of the other barium chemicals are made, were reported by two plants. The total showed slight increases in both quantity and value, as compared with 1930.

Canadian Gypsum in 1931

A REVIEW of the gypsum industry and vital statistics about production of gypsum and gypsum products has been issued by the Dominion Bureau of Statistics. Data on world production is also included. It reports that during 1931, 863,752 short tons of gypsum valued at $2,111.517 were produced from Canadian deposits as compared with 1,070,968 tons worth $2,818,788 in 1930. Gypsum quarried during the year totaled 882,880 tons, of which 167,335 tons, or 18.9%, was calcined in Canada, representing an increase of 3.6% in quantity calcined over that of the previous year.

Canadian Production of Cement and Lime in 1931

DATA have been issued by the Dominion Bureau of Statistics on the production of cement in Canada in 1931. Output, sales, stocks on hand, imports, exports, sales by provinces and information on labor, power and value of product are included.

The bureau has also issued data on the production of lime, by provinces, and the purposes for which the lime was used or sold. The analysis of distribution should be of interest to all lime producers.

PRODUCTION OF LIME IN CANADA, BY PROVINCES, 1931, SHOWING PURPOSES FOR WHICH USED OR SOLD

		Nova Scotia and New Brunswick	Quebec	Ontario	Manitoba and Alberta	British Columbia	CANADA
QUICKLIME							
Building trades—							
Finishing lime	tons	......	74	4,187	1,985	250	6,496
	$	......	842	29,749	18,744	4,000	53,335
Masons' lime	tons	880	8,208	17,773	3,013	......	29,874
	$	10,500	100,910	143,875	27,956	......	283,241
Sand-lime brick	tons	......	2,898	8,064	457	......	11,419
	$	......	18,631	57,738	4,297	......	80,666
Agriculture	tons	410	2	10,540	......	......	10,952
	$	4,750	16	73,788	......	......	78,554
Chemical—							
Smelters	tons	......	105	478	3,025	1	3,609
	$	......	1,067	3,276	24,282	10	28,635
Iron and steel mills	tons	16,665	250	4,240	......	......	21,155
	$	68,519	2,200	30,706	......	......	101,425
Cyanide mills	tons	......	......	17,997	68	70	18,135
	$	......	......	123,730	997	1,250	125,977
Pulp and paper mills	tons	2,998	41,397	763	9,907	11,848	66,913
	$	25,358	242,262	5,448	68,032	107,803	448,903
Glass works	tons	......	364	5,185	580	......	6,129
	$	......	2,730	40,379	5,298	......	48,407
Sugar refineries	tons	210	75	8,769	2,400	......	11,454
	$	1,800	787	83,641	21,600	......	107,828
Tanneries	tons	......	173	1,686	......	......	1,859
	$	......	1,919	12,928	......	......	14,847
Other chemical works	tons	......	39,990	33,681	196	129	73,996
	$	......	279,930	236,850	1,630	1,278	519,688
Dealers—uses unspecified	tons	1,788	6,441	10	......	480	8,719
	$	23,820	56,160	80	......	5,560	85,620
Other consumers	tons	......	1,209	3	......	7,586	8,798
	$	......	12,595	86	......	75,177	87,858
Total quicklime	tons	22,951	101,186	113,376	21,631	20,364	279,508
	$	134,747	720,049	842,274	172,836	195,078	2,064,984
HYDRATED LIME							
Building trades—							
Finishing lime	tons	25	150	24,048	4,501	......	28,724
	$	400	1,357	276,808	81,350	......	359,915
Masons' lime	tons	430	975	8,182	......	......	9,587
	$	5,800	9,487	81,545	......	......	96,832
Sand-lime brick	tons	......	......	358	......	......	358
	$	......	......	3,659	......	......	3,659
Agriculture	tons	360	91	281	......	580	1,312
	$	4,700	740	2,810	......	3,289	11,539
Chemical—							
Smelters	tons	......	......	75	......	2,530	2,605
	$	......	......	788	......	21,903	22,691
Iron and steel mills	tons	......	......	3	......	......	3
	$	......	......	37	......	......	37
Cyanide mills	tons	......	......	25	......	......	25
	$	......	......	263	......	......	263
Pulp and paper mills	tons	5,400	3,411	109	......	4,060	12,980
	$	55,500	27,215	1,145	......	36,495	120,355
Glass works	tons	......	......	......	......	......	......
	$	......	......	......	......	......	......
Sugar refineries	tons	65	......	......	......	......	65
	$	925	......	......	......	......	925
Tanneries	tons	......	125	5	......	......	130
	$	......	1,025	52	......	......	1,077
Other chemical works	tons	440	325	1,198	......	284	2,247
	$	4,400	2,769	12,889	......	2,479	22,537
Dealers—uses unspecified	tons	......	5,233	......	......	76	5,309
	$	......	41,576	......	......	637	42,213
Other consumers	tons	......	......	......	......	1,932	1,932
	$	......	......	......	......	17,388	17,388
Total hydrated lime	tons	6,720	10,310	34,284	4,501	9,462	65,277
	$	71,725	84,169	379,996	81,350	82,191	699,431
Grand total—Lime	tons	29,671	111,496	147,660	26,132	29,826	344,785
	$	206,472	804,218	1,222,270	254,186	277,269	2,764,415

The Recast Analysis and Its Relation to the Chemistry of Portland Cement*

Part IV—Course of Crystallization

By Louis A. Dahl
Research Chemist, California Portland Cement Co., Colton, Calif.

IT HAS BEEN shown that when extraneous substances are present, it is an advantage to express the composition of such extraneous substances in terms of potential composition, as a means of judging the direction in which actual compound composition will be altered by their presence. The application of computations of potential composition to such problems has been illustrated by computations involving the percentage of undercooled melt, or glass. This application will now be extended to the problem of investigating the course of crystallization, and of determining the percentage and composition of the melt during the heating and cooling of mixtures through a range of temperatures in which a liquid phase, or melt, appears.

In their study of the ternary system, CaO-Al_2O_3-SiO_2, Rankin and Wright treated this problem graphically, and showed that it is possible to predict from the phase diagram the order in which the crystalline phases will appear and disappear, and the percentage and composition of the liquid phase which will be present at any stage of the process of heating and cooling through a range of temperatures in which a liquid phase is in equilibrium with the crystalline phases which are present. The graphic method used by Rankin and Wright is suitable for such study when only three components are involved. It can be used, but with considerable difficulty, in the investigation of four-component systems. If more than four components are involved, the graphic method cannot be used. A more general method, applicable to any number of components, is needed in the investigation of the course of crystallization in portland cement clinker, because of the large number of components involved.

> ***IN THE PREVIOUS articles, published in Rock Products June 18, July 16 and August 13, the author gave methods of developing formulas to replace some of the old ratios in expressing the relation between components of raw materials used in the manufacture of portland cement.***
>
> ***In the present article geometrical methods are used to explain the progress of the melt and the course of crystallization.***
>
> ***The Editors.***

In their graphic treatment of the course of crystallization Rankin and Wright made use of the principle that any triangle appearing in the triangular diagram representing the final products of crystallization (Fig. 3) may be treated as a separate and distinct ternary system. This is equivalent to considering the compounds at the vertices of such a triangle as components. It is consequently equivalent to considering compositions in terms of potential composition. In our study of the problem we shall not confine ourselves to the graphic method. The aim will be to consider the three-component system by the graphic method, and by the method of computed potential composition, as a means of extending the study to systems of more than three components, such as the system involved in portland cement clinker.

In Fig. 10 a portion of the CaO-Al_2O_3-SiO_2 triangle is shown. In this figure the broken lines represent the C_3S-C_2S-C_3A triangle on a larger scale than in Fig. 3. The curved lines are boundary lines separating primary phase regions, as found by Rankin and Wright. A primary phase is a crystalline phase which is first to separate out when a molten mixture is cooled. In the region between the CaO point and the curved lines CaO is the primary phase. As a mixture located in that region is slowly cooled from a molten state, CaO is the first solid phase to appear.

Let us consider the composition *M*, which is in that region. As it is slowly cooled from a molten state to its fusion point, no solid phases appear. Upon further cooling, CaO separates out as a solid phase. The removal of CaO from the liquid changes its composition, so that the composition of the liquid phase is no longer represented by the point *M*. If *M*, the original composition, is now considered as a mixture of the solid phase and the liquid phase, it is evident from our previous study of Fig. 2 that the composition of the solid phase, the liquid phase and the original composition *M* must lie in a straight line, with the composition *M* at an intermediate point.

After the separation of CaO has begun, the composition of the melt must therefore be on an extension of the straight line joining *M* and CaO, in a direction away from the CaO point. The melt consequently changes in composition from *M* to *P* during the separation of CaO. The proportion of melt and of CaO is determined by the position of the melt composition on the line *MP*. For instance, when the melt has reached the composition *P* the fractional proportion of melt is equal to the length of the line from CaO to *M* divided by the length of the line from CaO to *P*; similarly, the fractional proportion of the solid portion, CaO, is equal to the length of the line *MP* divided by the length of the line from CaO to *P* (See discussion of Fig. 2).

The change in melt composition from *M* to *P* represents a condition of falling tem-

perature. The solid phase CaO appears when the molten mixture M is cooled to its fusion point. The composition of the melt reaches the point P when the temperature has been reduced to the fusion point of a composition P. Every point from M to P consequently represents a definite temperature. If the temperature is maintained at any one of these intermediate temperatures for an indefinite period, the mixture will consist of a melt of definite composition, and CaO. If no heat is added or removed, the proportion of CaO, and the proportion and composition of the melt, will remain unchanged. This condition is described as a state of equilibrium, and the CaO primary phase region consequently represents a range of composition of melts which may exist in contact with CaO without change.

The composition P is on the boundary line separating the CaO and C_2S primary phase regions. A melt of this composition is in equilibrium with both CaO and C_2S, so that on further cooling of the mixture M it may be expected that both C_2S and CaO will be present in the solid portion. The composition of the melt changes along the line PR. For any melt composition between P and R it is possible to determine graphically the proportions of the phases which are present. Let us consider the point R. Considering M as a mixture of the liquid portion and the solid portion, the point representing the composition of the solid portion must be on an extension of the line joining M and R, in a direction away from R.

At the same time it is known that the solid portion is composed of CaO and C_2S, and that it must therefore be on the line joining CaO and C_2S. The composition can be on both of these lines, as required, at the point L, which is at the intersection of the two lines. The proportions of CaO and C_2S in the solid portion are determined by the lengths of the lines L-C_2S and L-CaO respectively. The proportions of solids and liquid respectively are determined by the lengths of MR and ML.

The course of crystallization has been traced from the original molten condition to the appearance of a second solid phase, and from that point to a point R at which three solid phases, CaO, C_2S and C_3S, may exist in equilibrium with the melt. The point R represents a definite temperature (1900 deg. C.); the melt can remain in equilibrium with the solid phases only if that temperature is maintained. If the liquid is cooled below that temperature the melt continues to change in composition in the direction of falling temperatures.

The curves RS and RT represent such a change, and it is necessary to determine which of these curves will be followed. If the curve RT is followed, the phases at equilibrium are C_3S and C_2S. The solid portion must therefore have a composition lying between the C_3S and C_2S points. This is impossible, because the composition of the solids at the beginning point of the curve (the point R) is at L, which is not between the C_3S and C_2S points. A change in composition of the melt along the curve RT is consequently eliminated. Following the curve RS, the composition of the solid portion must lie at a point between the CaO and C_3S points, which is true in this case; the point L is between CaO and C_3S. From this we know that the curve RS is followed from the point R. As the melt approaches R, the solid phases are CaO and C_2S; as it leaves R, the solid phases are CaO and C_3S. It follows that the C_2S must disappear at R, or as the melt is leaving R.

The composition of the melt proceeds along the line RS to the point X, which is on the extension of the line C_3S-M. The solid phases during this change in composition of the melt consist of CaO and C_3S. As the melt moves from R to X, the solid portion moves along the CaO-C_3S line from L to C_3S. When the melt reaches the point X, the solid portion arrives at C_3S, which indicates that at that time C_3S is the only solid phase present. From this it is known that as the melt moves from R to X, CaO is disappearing from the solid portion, while C_3S is increasing.

After the melt has reached X it is impossible for it to follow the line RS any farther. This is evident from the fact that a straight line drawn from any point on XS through M will not meet the straight line joining the CaO and C_3S points, which represent the primary phases which are at equilibrium with the melt along the line XS. The melt consequently leaves the boundary curve RS and crosses the C_3S region to Y. The line XY is an extension of the line passing through C_3S and M. During this time C_3S separates out alone, since it is the only solid phase in equilibrium with the melt.

The line XY intersects the C_2S-C_3A line at Z. This point is of special interest because at this point the C_3S which has crystallized out is equal in amount to the amount in the potential composition; that is, the amount of C_3S present as a solid phase when the melt arrives at Z is the same as the amount which is present when crystallization is complete. As the melt passes from Z to Y the proportion of C_3S present as a solid phase increases, and is therefore greater than the proportion of C_3S which will be present when crystallization is complete. This is true whenever the melt is at a point to the right of the C_2S-C_3A line (that is, away from the C_3S point), according to principles already discussed in connection with the influence of extraneous substances.

When the melt reaches the point Y, it changes in direction, moving in the direction of falling temperatures from Y to T on the boundary curve ST. On this boundary curve the melt is in equilibrium with C_3S and C_3A. The composition of the solid portion when the melt is at any point between Y and T is found by drawing a straight line from the point to M, and extending the line to the C_3S-C_3A line, which it cuts in proportions

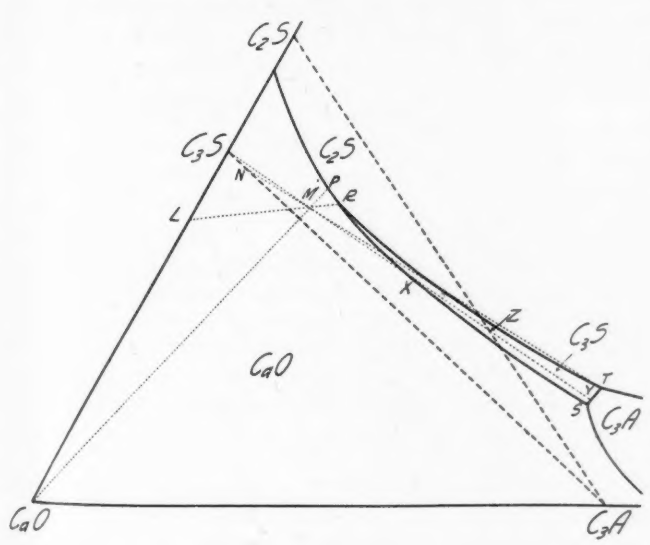


Fig. 10. Portion of CaO·Al_2O_3·SiO_2 triangle to show progress of melt

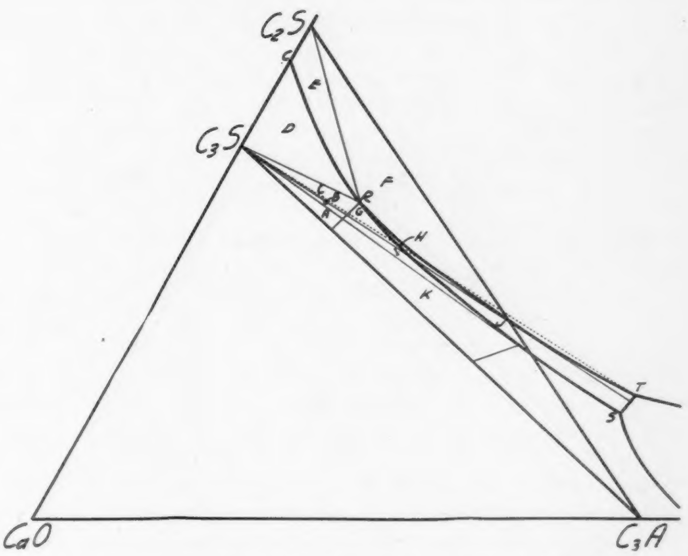


Fig. 11. Diagram divided to show various fields in the process of crystallization

corresponding to the relative proportions of C_3S and C_3A in the solid portion. When the melt arrives at T, the solid portion has the composition N, the proportions of C_3S and C_3A being determined by the lengths of the lines C_3A-N and C_3S-N respectively.

The point T is at the intersection of three boundary curves which bound the regions in which C_3S, C_2S and C_3A are primary phases. The point T is common to the three regions, so that all three of these phases may exist in equilibrium with the melt. It should be noted that these three phases are the compounds indicated at the vertices of the triangle in which the original composition M is located, and that T is consequently the final composition of the melt. Crystallization now proceeds with no change in composition of the melt, all three phases, C_3S, C_2S and C_3A, being present until the last drop of liquid has disappeared. When crystallization is complete proportions of the three compounds in the cooled product are the same as calculated in the potential composition.

It should be noted that when the melt reaches the point T the proportion of C_3S is greater than the potential C_3S, the proportion of C_3A is less than the potential C_3A, in fact, much less, and that C_2S is not present. As crystallization proceeds at the point T, the C_3S decreases, C_3A increases, and C_2S appears and increases, until the calculated proportions of these compounds are present. If, after the melt has passed the point Z, the process of cooling is hastened, so that any or all of the melt is solidified to a glass without opportunity to crystallize, the percentage of C_3S will be greater than the potential amount; C_2S and C_3A may be present in negligible amounts, or may even be absent. In the case of the composition M, C_2S is more likely to be absent than C_3A under this condition, since it does not crystallize until the melt arrives at T. If quenched between X and Y, neither C_2S nor C_3A will be present. If quenched between Y and T, C_2S will be absent, but C_3A will be present in small amount. If quenched while crystallization is proceeding at T, both C_2S and C_3A will be present, the amounts depending upon the amount of melt which has disappeared at the time when the mixture is quenched.

The study of the crystallization of composition M illustrates the manner in which the course of crystallization of a particular composition may be predicted from the phase diagram. At various stages of the process of tracing the crystallization curve it is necessary to make a choice between two courses, either of which is apparently possible. Actually only one is possible, and the choice is made by testing one after another to determine which is the possible course.

A line is drawn from a point on the course in question through the point representing the original composition. It is then observed whether the solid phases which that course indicates to be in equilibrium with the melt can possibly be formed. It is evident that the entire course of the melt (the crystallization curve) is dependent upon the original composition, and its position in the phase diagram. The triangle C_3S-C_2S-C_3A may be divided into various fields, each of which has its own order of crystallization. In Fig. 11 a portion of the phase diagram by Rankin and Wright has been divided into such fields, and designated by the letters A to K. The solid phases in equilibrium with the melt as crystallization proceeds are indicated below.

Field A. CaO; CaO, C_2S; CaO, C_2S, C_3S; CaO, C_3S; CaO, C_3S, C_3A; C_3S, C_3A; C_3S, C_2S, C_3A.

Field B. CaO; CaO, C_2S; CaO, C_2S, C_3S; CaO, C_3S; C_3S; C_3S, C_3A; C_3S, C_2S, C_3A.

Field C. CaO; CaO, C_2S; CaO, C_2S, C_3S; CaO, C_3S; C_3S; C_3S, C_2S; C_3S, C_2S, C_3A.

Field D. CaO; CaO, C_2S; CaO, C_2S, C_3S; C_2S, C_3S; C_2S, C_3S, C_3A.

Field E. C_2S; CaO, C_2S; CaO, C_2S, C_3S; C_2S, C_3S; C_2S, C_3S, C_3A.

Field F. C_2S; C_2S, C_3S; C_2S, C_3S, C_3A.

Field G. CaO; CaO, C_2S; C_3S; C_3S, C_2S; C_3S, C_2S, C_3A.

Field H. C_3S; C_3S, C_2S; C_3S, C_2S, C_3A.

Field I. CaO; CaO, C_3S; C_3S; C_3S, C_3A; C_3S, C_2S, C_3A.

Field J. C_3S; C_3S, C_3A; C_3S, C_2S, C_3A.

Field K. CaO; CaO, C_3S; CaO, C_3S, C_3A; C_3S, C_3A; C_3S, C_2S, C_3A.

In addition to the fields listed above there are three fields bounded on one side by the straight side joining C_3S and T (Fig. 11). Because of the scale of the drawing, these fields are not designated by letters. They are located as follows: (1) between fields B and C; (2) between fields H and I; (3) between fields H and J.

When a mixture of C_3S, C_2S and C_3A at the temperature of the melt at T (1455 deg. C.) is heated slowly, the process described is reversed. The temperature remains at 1455 deg. until all of the melt of composition T which can form is present. The maximum amount of melt of that composition is formed when one of the solid phases disappears. The phase which disappears must be C_2S or C_3A, depending upon the original composition. The percentage of C_3S increases during this process. As the heating is continued, the melt follows the crystallization curve which would be followed in the crystallization of the mixture starting from a molten state, but in the opposite direction.

For compositions in any of the fields listed above, the solid phases appear and disappear in an order just the reverse of the order indicated for the process of crystallization in that field. The boundaries of these fields consequently represent lines of demarcation between compositions differing in the process of burning. This difference in behavior may be of little significance in processes in which the rate of heating and cooling is so slow that equilibrium between solid phases and the melt is maintained continuously, and crystallization is complete. But in a process of burning which is too rapid to permit the attainment of a continuous state of equilibrium, and complete crystallization, so that the undercooled melt, or glass, appears in the product, these differences in behavior become significant. In the control of composition in such a process it would be important to confine the compositions to one field.

Some of the fields in the C_3S-C_2S-C_3A triangle are quite unlike in the first stages of the process of crystallization from a molten condition, but are similar in the later stages. Compositions in such fields may be considered similar in their behavior in processes of burning which do not proceed to complete fusion. In such a process, as in the manufacture of portland cement from raw materials composed of CaO, SiO_2 and Al_2O_3, the number of fields differing in their behavior is consequently reduced. If the temperature attained in the process of burning, for instance, is not high enough to permit the existence of CaO as a stable phase in equilibrium with the melt, the lines separating the fields A and K, fields B and I, and fields C and G have no significance.

It will be observed that all of the straight lines separating fields in Fig. 11 pass from a point representing a solid phase to a boundary curve, meeting the boundary curve either at a point of tangency, or at a point of intersection of two boundary curves. This is of importance in formulating mathematical expressions which might be required if it is desired to control compositions so that they will always be in one field. Any line passing through the point representing C_3S, for instance, represents compositions having the same ratio of potential C_2S to C_3A.

This may be illustrated in the case of the line separating fields C and D. According to Rankin and Wright, the point R has the composition 68.4% CaO, 9.2% Al_2O_3, 22.4% SiO_2. Applying the equations for calculating potential composition, this corresponds to 46.4% C_3S, 29.2% C_2S, 24.4% C_3A. The ratio of C_2S to C_3A is 1.20. Since all compositions on the line separating fields C and D have the same ratio of C_2S to C_3A, the C_2S/C_3A ratio of the line is 1.20. All compositions in field D have a C_2S/C_3A ratio greater than 1.20. All compositions in field C have a C_2S/C_3A ratio less than 1.20.

(*To be continued*)

Stone Sand as a Filler

TESTS for load characteristics, compressibility and mechanical strengthening in the order of their superiority are reported by Willi Drescher in *Asphalt Teer Strassenbautech.* They are reported in the following order: Limestone, copper slag, "Syntholith," "Ilseder" stone, sandstone, portland cement, volcanic slag, slate, hydraulic cement, lime and porphyritic quartz. Stone sands of low specific gravity are reported as not generally suited for tar- or asphalt-concrete.—*Chemical Abstracts.*

Activities of Committee on Concrete and Concrete Aggregates

A. S. T. M. Committee C-9 on Concrete and Concrete Aggregates has more than 100 items listed in its docket of current activities. Some of the more important items are outlined below.

The subcommittee on strength tests has studies in progress on methods of capping, on loading beams, and a method of measuring cores drilled from a concrete structure. A suggested standard test method for permeability and the standardization of test methods for absorption are active projects of the subcommittee on permeability. The subgroup on aggregates has more than 20 items listed including studies of soundness, abrasion, light weight types, etc. Standardization work involves tests to ascertain the amount of soft and rotten particles, specific gravity, alternate mortar test for sand, etc. The subcommittee on extraneous substances in concrete is working on the effect of mica in sands, effect of organic matter and oil bearing aggregates and a standard color solution.

Several other subgroups of Committee C-9 have important problems before them. The subcommittee on admixtures is developing a method of measuring unit weight and the normal consistency of these materials. A standard method of test for determining volume changes in concrete is being worked up by the group covering elasticity and volume changes. The subcommittee on durability has several items to forward including the development of test methods for measuring durability and the method of making freezing-and-thawing tests. A proposed method for this latter project was appended to the annual report of Committee C-9 presented at the recent A. S. T. M. annual meeting. Consideration is being given by a subgroup to proposed tentative specifications for ready-mixed concrete.

Claims Sand Preserves Fruit and Vegetables

EXPERIMENTS of C. A. Williford, Niland, Calif., have proven sand as a substitute for cold storage for the preservation of grapefruit. Sweet potatoes also may be kept for months by this inexpensive method.

Last January Mr. Williford placed a fine layer of desert sand 6 in. deep on the floor of a brooder on which was spread a layer of freshly plucked grapefruit. Then came another layer of sand and another layer of grapefruit until he had buried 50 boxes of the product.

Nearly seven months later the first of the grapefruit was sampled and Mr. Williford said it proved fresh and firm.—*Toledo* (Ohio) *Times.*

Hanford MacNider Comments on Cement Industry

IN A LETTER to stockholders, dated August 15, Hanford MacNider, president of the Northwestern States Portland Cement Co., Mason City, Ia., says:

"Everyone interested in the cement industry is doubtless aware that there was an increase in the market price of portland cement in our territory during the latter part of July. No actual benefits from this increase could be expected immediately but we were able nevertheless to show a small operating profit after depreciation and depletion for the month of July. While we cannot hope to show substantial profits as the result of operations for the current fiscal year, the management of the company feels distinctly encouraged over the prospects for the next four months. With a continuation of present conditions during this period we shall make a much better statement to stockholders at the end of this fiscal year than we did last year, notwithstanding the fact that shipments are only approximately 50% of those in 1931.

"The splendid cash position of the company has been maintained throughout this period of depression and the plants and properties have never been in a better physical condition than they are today.

"As a result of the first eight months' operation, for the current fiscal year we have made substantial gains in financial position as compared with the same period in the 1931 fiscal year. The net loss has been cut in two; wages and personnel have been reduced in the manufacturing department and efficiency increased to a point where costs operating at 50% plant capacity compare favorably with the best years at full capacity. General expense and selling expense have both been substantially reduced by the reduction of personnel and reductions in salaries.

"The injunction suit brought by a local attorney to prevent the transfer of the assets of the West Virginia corporation to the Iowa corporation has not yet come up for hearing, notwithstanding repeated efforts on the part of the company's attorneys to bring it to trial. The directors of the company at their last meeting instructed the officers to notify the plaintiff that we would proceed with the transfer in accordance with the terms of the reorganization agreement unless temporary injunction was applied for. As a result of this notice, application was filed by the plaintiff for a temporary injunction. Hearing on temporary injunction was held July 25. The judge granted the attorneys 25 days for filing of briefs, and we cannot expect a decision on the temporary injunction until the latter part of this month. Whether the temporary injunction is granted or not, the original suit for the permanent injunction will have to be heard, and we hope to have this case brought up for trial in the fall term of court. While the delay has been and still is annoying, our attorneys are reasonably confident that the outcome will be favorable and that the company will be able to complete its reorganization as planned.

"The board of directors, the president and other officers feel encouraged over both the company's prospects and that of the cement industry as a whole. We are more than holding our own, and with continued improvement in conditions we shall be in a preferred position to take advantage of the situation and return our operations to a worthwhile and profitable basis."

Geologists Make Tour of Investigation

THE OIL, GAS AND MINERAL RESOURCES of southern, southeastern and northern Kansas, western Missouri and southeastern Nebraska are to be explored thoroughly by a party of 100 prominent geologists from eight western states, the national government at Washington, eastern universities, and from the geological forces of a dozen or more middle western oil producing companies, according to Dr. George E. Condra, state geologist of Nebraska.

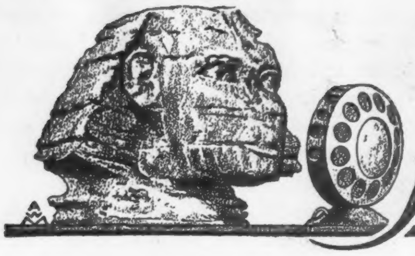
The party was to assemble at Wichita, Kan., August 28, and disperse at Lincoln, Neb., September 3. The object of the exploration was to trace and map the outcroppings of the Pennsylvanian and Parmian and other rock strata and to prepare data to be used in the prosecution of the search for oil, gas and minerals in that territory. The party traveled in a caravan of 50 automobiles.—*Chicago* (Ill.) *Journal of Commerce.*

To Exhibit at a Century of Progress World's Fair

THE JOHNS-MANVILLE CORP., New York, N. Y., will build an exhibit house for the Century of Progress Exhibition to be held at Chicago in 1933. It will be constructed, so far as possible, of materials manufactured by the company. This will include insulation materials of mineral wool and asbestos, as well as the application in sound control and acoustical correction. The fire and weather resistance of its materials in particular will be featured, it is stated.

Specializes in Mine Cost Accounting

ALBERT E. KELLER, formerly chief mine accountant, United States Bureau of Mines, has started a private practice specializing in accounting matters and office efficiency for the mining industry with headquarters in Chicago, Ill. While with the Bureau of Mines Mr. Keller made a study of mine accounting methods, being familiar with the work of the bureau in standard cost accounting for the gravel and crushed stone industries.



Hints and Helps for Superintendents

Some Dirt-Moving Hints and Helps

By D. B. Patterson
Vice-President, Harnischfeger Corp., Milwaukee, Wis.

IN MY FIELD CONTACTS I occasionally hear of small things that will materially help the contractor and operator of excavating equipment. This applies to any make of excavator, although in the cases cited the machines have been types and models of the P&H line.

Load More Dirt

There are some factors affecting the operating cycle of a shovel. The operating cycle of a shovel can be divided into four consecutive actions, namely: loading the dipper, swinging over the hauling unit, dumping the spoil, and swinging back into digging position. Moving forward may be classed as a necessary interruption.

In ordinary excavation, 4 or more feet in depth, a 1-yd. shovel should make at least two complete cycles per minute—providing hauling devices, such as trucks, are so placed that the average swing does not exceed 90 deg.

The time allowances per cycle are: filling the dipper, 12 sec.; swinging and spotting over truck, 9 sec.; dumping, 2 sec.; returning to digging position, 7 sec. The following hints may help maintain this schedule:

Filling Dipper: Keep the dipper teeth sharp. Move forward frequently. Clean up the floor, permitting dirt to slide down into a loose heap.

Swinging and Spotting: Hoist while swinging. Keep hauling equipment close to cut, thus avoiding a long swing. The difference in swinging 90 deg. compared with 180 deg. may cut the output 25%. Do not swing too fast when approaching the wagon.

Dumping Spoil: When the dipper is nearing tripping position take up the slack in the trip rope. Start swinging back as soon as the trip is released.

Start swinging back as soon as the trip is released

Swinging Back to Dig: Start lowering dipper and reverse the crowd, being ready to crowd forward when the dipper strikes the ground.

A fast operator is not the only essential for fast loading. He can only dig what the equipment can haul. If the wagons or trucks are inadequate, or if they are poorly managed, maximum output cannot be expected.

Dragline Efficiency

With the help of Frank R. Kuhn, contractor of Winamac, Ind., I am passing along some proven dirt moving hints which point to more economical dragline operation. Mr. Kuhn is an experienced operator and a very successful excavating contractor.

When starting a cut with a dragline, begin close to the machine. By so doing much time can be saved over the method of casting the bucket to the maximum distance at the very beginning. Move the dirt which lies close to the machine first. The more distant dirt will have a tendency to follow into the cut. When the bucket is full, hoist out and get rid of it. Much time and power are wasted when the bucket is pulled along after it is full.

When the dirt is kept cleaned away from the front of the machine, the cable does not bury itself when the bucket is hauled in. This not only lengthens the life of the cable but also enables the operator to cut a smoother, more accurate slope. Furthermore, greater depth can be attained close up to the machine.

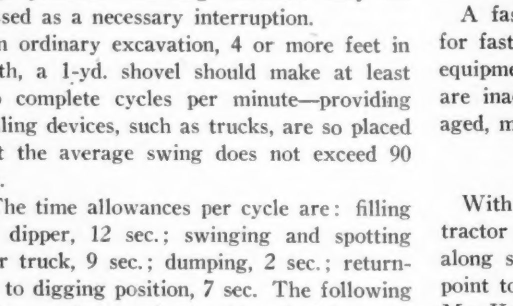
Hoist and drag cables should be kept tight. When the bucket is cast with the drag cable slack, it may land upside down, backward, side way or most any other way. This practice not only causes kinking and breaking of the cable but also results in lost time.

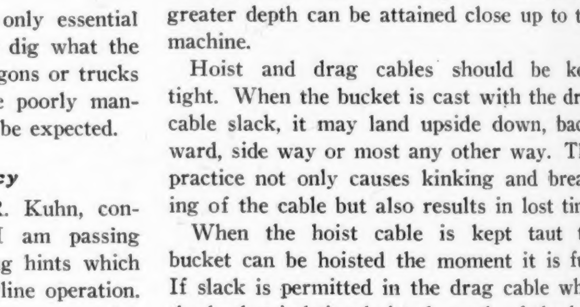
When the hoist cable is kept taut the bucket can be hoisted the moment it is full. If slack is permitted in the drag cable while the bucket is being hoisted, much of the load spills out.

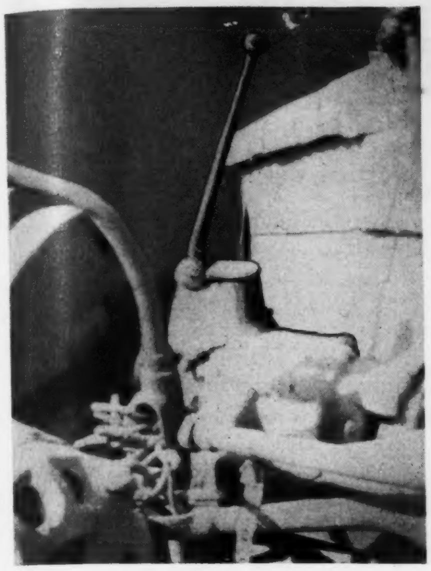
Truck Transmissions Used as Speed Reducers

By Dare Paris
Monrovia, Calif.

THE ACCOMPANYING illustration shows a transmission taken from an old motor truck and used for a gear reduction on a 20-in. conveyor belt. On this conveyor two transmissions are used. These are placed end to end and hooked direct to the head pulley on the conveyor. The transmissions are run, one in low







Gives reduction of 30 to 1

and the other in reverse. This gives a gear reduction of about 30 to 1. A belt drive is used from the motor to the transmission. By using different size pulleys nearly any speed ratio can be obtained. The belt is run on 125-ft. centers and carries about 1800 sacks of cement a day.

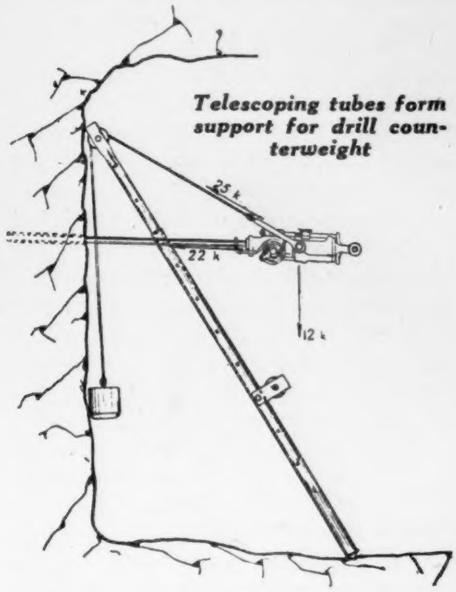
Conveyor Underpass

THE PRIMARY CRUSHER at the plant of the Unadilla Valley Sand and Gravel Co., S. Edmeston, N. Y., is at one side of the state highway and the washing and screening plant is on the other.

At the primary crusher two products are made which are kept separate throughout the remainder of the flow sheet. To do this it is necessary to have two belts from the primary crusher to the plant. The belts, a 30-in. and a 24-in., pass under the state highway through concrete tunnels which are ordinary 48-in. concrete sewer tile. A subsidiary company of the Unadilla Valley company, which makes concrete products, supplied the sewer tile. These tile make a very serviceable tunnel and one that is easy to install.

Counterweight Supports for Rock Drills

A NEW DEVICE for relieving hard labor in the manipulation of rock drills for horizontal boring is described in *Mines and Carrieres*. As will be seen in the illustration, the arrangement comprises two hollow telescopic tubes, the upper one containing a



Telescoping tubes form support for drill counterweight

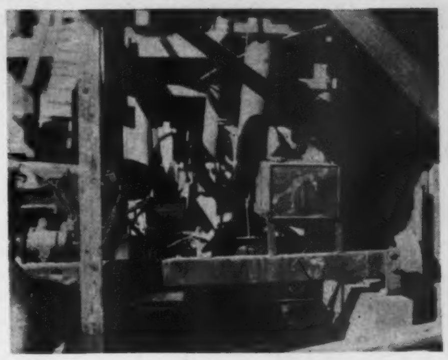
sheave, through which is passed a rope or chain, one end carrying a counterweight and the other attached to a stirrup on the drill.

The other pulley shown is used when holes are drilled at a short distance from the floor. This appliance can be employed for drilling holes on an inclined face, and with the addition of a collar attached to the upper tube, for drilling vertical holes in the roof.

Using Old Motors for Power

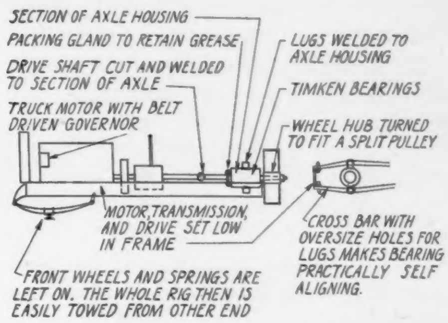
By Ernest Moyer
Alturas, Calif.

AT OUR PLANT we are unable, as yet, to obtain satisfactory electric power service. We originally had a 25-hp. semi-Diesel engine which was the main source of power. This was augmented with truck mo-



Mounts old motors on truck frames

tors, which were mounted as shown in the accompanying illustrations. By mounting on a truck frame, as shown, these power plants are really portable, which feature is a great advantage at times. These units have rendered remarkable service for us and the speed change ratios available through the transmission sometimes are most convenient. We have found the Timken bearings, carry-



ing the heavy belt drive, trouble free. In preparing these power units we made considerable use of arc welding, which simplified an otherwise more difficult job.

Water Trap for Air Lines

IN QUARRY DRILLING by means of air drills the moisture in the air lines is often the cause of considerable trouble and delay in cold weather. This is due to the freezing up and gradual closing of the exhaust part of the drill, resulting from the lowering of the temperature by the expansion of the air.

The accompanying illustration shows a simple method of trapping any excess moisture out of the air by passing it through a length of 8- or 10-in. pipe. The pipe is set on a slope so that the moisture drains to the lower end and is then drawn off at intervals through a small valve connected to the lowest point.

Concrete sewer tile make conveyor tunnel under highway

Large pipe serves as trap

Rock Products Clinic

Classification Calculations

THE EDITOR: The article in your issue of August 13, "A Study of Classification Calculations," contributed by Messrs. Harry W. Newton and William H. Newton, presents the development of a formula for determining classifier efficiency, which is recommended as a substitute for the one generally employed by air separator builders and advocated by me in a previous discussion of air separation. A considerable portion of the article is devoted to adverse criticism of the formula which I sponsored, and since this criticism is based upon misconception, I desire to submit a brief rejoinder.

Dealing with air separation, the Newtonian concept may be briefly summarized as follows:

1. The separator cannot make a perfect product.

2. Separator undersize invariably contains oversize material which contaminates the undersize product, and the performance of the separator, from the standpoint of efficiency, should be penalized accordingly.

3. Separator undersize invariably carries unclassified feed.

My own position in respect to the foregoing is precisely the opposite and—given a separator in proper adjustment—may be stated:

1. The separator makes a perfect product in the sense that 100% of the separator undersize is acceptable as a finished product.

2. Separator undersize under these circumstances contains no oversize material which may be considered as a contamination of the finished product or is subject to penalty.

3. Separator undersize carries no unclassified feed.

In support of my position, a previous example will be reviewed. A separator is handling a feed of 135 tons per hour and making a finished product screening 90% through 200-mesh. Samples from the separator disclose the following:

Separator feed (A) 60%–200, or 66⅔% of required material.
Tails (B) 36%–200, or 40% of required material.
Finish (C) 90%–200, or 100% of required material.

$$\text{Efficiency, } E = \frac{.90\ (.60-.36)}{.60\ (.90-.36)} = 66\tfrac{2}{3}\%,$$

$$\text{or,}\quad E = \frac{1.00\ (.66\tfrac{2}{3}-.40)}{.66\tfrac{2}{3}\ (1.00-.40)} = 66\tfrac{2}{3}\%.$$

I cannot agree that efficiency is 55.55% as your contributors have it. We introduce into the separator 90 tons per hour of the required material and we recover 60 tons per hour of this material; furthermore, this 60 tons is a highly classified product carrying no oversize or unclassified feed. There is no justification for considering the 10% residue on 200-mesh as an oversize to be charged against the efficiency of the separation. We are not attempting to make a product passing 100% through 200-mesh, and nothing was said in the original text that could be so construed, yet your contributors treat this 10% residue as a contamination and penalize the separator for performing in accordance with the requirements.

In the course of a prolonged test I had occasion to take numerous samples of finished product from a 16-ft. separator operating under a heavy circulating load and producing 82% through 200-mesh material. The feed to this separator screened 100% through 6-mesh and approximately 30% through 200-mesh, presenting a difficult separation problem; yet in no case was there any indication of coarse residue in the finished product, which screened 98% through 100-mesh, while the residue on 100-mesh very closely approached 100-mesh in size. Had unclassified feed been present, such material would have ranged upwards to 6-mesh, which decidedly was not the case.

With reference to the plugged separator mentioned by Messrs. Newton, it is difficult to conceive of a plugged machine discharging freely, however, it is obvious that no classification is taking place and efficiency is zero. In my definition of separator efficiency I referred to finished material recovered in a reasonable employment of the term and not in the sense of material discharged from a separator inoperative at the time.

Referring to the separator which is producing clean tails with 25 to 30% of "oversize" in the finished product, the solution is performed in the usual manner, simply considering the entire product as finished product, and consequently efficiency is 100%. If the finished product is unsatisfactory from the standpoint of particle size, the separator is not in proper adjustment. In my discussion of separator efficiency I took no account of a separator not functioning properly, but proceeded on the assumption that the separation in every instance was the desired separation.

If we are investigating a separator making an undersize product which is not fine enough to meet the requirements, obviously two courses are open to us: We may attempt to place the separator in proper adjustment, or, failing this, we may calculate efficiency in the ordinary way and apply a correction to the efficiency as computed. It is quite feasible to make such correction, as the calculation is by no means involved. Therefore, the Newton, or metallurgical, formula offers nothing that cannot be as readily attained by the employment of the methods already in vogue. A. W. Catlin.

Chicago, Ill.,
September 6, 1932.

Has Any One Data on Lime as "Explosive"?

THE EDITOR: I have looked through the bound volumes of yours and a few other magazines trying to locate data about the use of lime instead of dynamite or black powder for breaking up foundations, etc., where the shock of an ordinary explosive would not be permissible. Possibly you can assist me in this search.

"Chief Engineer."

Editor's Note

As everyone knows, lime, when hydrated, swells and exerts tremendous bursting pressure upon any container. Also, if confined, it generates high temperatures. Does anyone know how it can be confined and hydrated in a drill hole? Has any reader a knowledge of the use of lime as an "explosive"? If so, both the writer and the editor will be glad to hear from him.

Data Wanted on Comparison of Methods of Loading Quarry Stone

THE EDITOR: We are wondering if there is any appreciable difference in the percentage of dust made on the same stone by the same type of crusher when using hand-loaded stone as against steam-shovel loaded. The point we have in mind is that with steam-shovel loading all of the stone shot down, including fines made in the blasting, is included in the feed to the crusher. In a hand-loaded operation, particularly those where a certain percentage of the overburden is shot down with the stone, all or practically all of the dust and fines, and a good deal of the stone up to 2 in. is gobbled.

Should this make an appreciable difference it would, of course, mean that a crushing comparison would not be accurate, unless the same type of loading, as well as the same stone, be used.

If you have any data on this, we would appreciate hearing from you.

"Quarry Operator."

Editorial Comment

More Work and More Leisure

The President has all along emphasized the necessity for every employer to make as many jobs as possible—by shorter working days and a shorter working week. From his address at the opening of the national conference of banking and industrial committees, it is obvious Mr. Hoover considers this is not merely an emergency need, but probably a fixed policy for the future. Roger Babson and many other economists, publicists and thinkers generally hold the same view.

It is going to be hard for most of us to accustom ourselves to this new point of view because our whole experience in business has been to attempt to accomplish with one employe what previously has required two or more. We have succeeded admirably in developing and using labor-saving devices toward that end. And, of course, we are not going to stop such developments; no man with an engineering or scientific turn of mind for one moment thinks we should stop mechanical progress and development.

The President said, and nearly every employer will agree with him, that it is not the function of the government to set the number of hours of labor in a day, or the number of working days in a week, except for government employes. As he says, with all the various phases of employment and operation to be met with in private business, no general rule can be applied. Every employer will have to work out his own problem in his own way. What is wanted and needed above all else is some experimenting along this line by employers who grasp the real significance of the problem and have the courage of their convictions.

We see no reason why employers in the rock products industry should not do some experimenting if they have not already done so. Let them try two five-hour shifts per day with different crews of men instead of one ten-hour shift with a single crew. Or in the case of a 24-hour-a-day operation, like a cement mill, work four shifts of 6 hours.

Of course, at the start the men will have to suffer a loss of income, but the loss will be for a principle, a principle that must sooner or later be sold to every employe and employer alike. That principle is the ultimate establishment of a more equitable distribution of work, wages, profits and buying power. It may appear idealistic now, but we must come to it eventually—and not by government decree but by voluntary acceptance of the principle itself.

We have got to acquire a more philosophic attitude toward business and industry. We have got to realize that business and industry are designed and intended to serve the needs and desires of the human race, and that the human race was not intended to be the slave of an unmanageable industrial and commercial machine. If we have so developed the forces of nature as to take the load of manual labor and drudgery from human beings, and apparently we have, things should certainly be arranged by the managers of industry and commerce that as many human beings as possible are allowed to enjoy the time and profits saved.

It is not to be expected, of course, that a corporation with a million dollar investment in plant will be content to operate that plant six hours a day in order to provide a short work day. That would be the height of inefficiency and wastefulness of capital—and in the future, as in the past, we are going to aim at the total elimination of waste. The ideal solution would be to operate all plants 24 hours a day in short shifts with different crews, thus getting a maximum return on the capital investment and requiring a minimum of capital investment with a maximum of employment.

It is not to be expected that the American workman, born and bred to work as long as he is paid for, and ambitious to make all the money he can, will accept at once and enthusiastically a plan to limit his working day and his daily earnings. It is not to be expected that American business executives will readily accept the idea that they can make their businesses and industries succeed unless they give a lot more of their own time to them than such a scheme of things contemplates.

True, of course, that the majority of us find business the most interesting and enchanting occupation there is to exercise our minds and faculties; but that is merely because we are not completely civilized, or we are too much the victims of the inheritance and example of our worthy pioneer forefathers, whose conditions of life required 12 to 18 hours of labor a day for mere existence.

We don't mean by this that we as Americans should cease to glorify work and industry, and look forward to leisure as the only goal in life. But the nature of our glorification of work should change. Instead of trying to do as much of the world's work as possible individually for our personal gratification and profit we must try to share as much work as possible with others, that they may support themselves in comfort and that we as well as they may have some leisure and time out for other things than work.

To our mind the acceptance of this principle already by so many in all walks of life is the really constructive thing that has come out of the depression. We are convinced that if employer and employe alike will make sacrifices for that principle now, the time is not so far distant when wages and incomes will be higher than they were in 1929, and working days and working weeks will be much shorter for all. And because of the progress we shall continue to make in mechanical production of goods and services our wages and incomes will buy us many more comforts and luxuries—and we shall achieve in some measure at least the greatest of all luxuries, *earned leisure,* for all; and not enforced and debasing idleness for some and a double measure of work and responsibility for the rest.

Financial News and Comment

RECENT QUOTATIONS ON SECURITIES IN ROCK PRODUCTS CORPORATIONS

Stock	Date	Bid	Asked	*Dividend
Allentown P. C. 1st 6's[47]	9- 7-32	95	100	
Alpha P. C. com.[2]	9- 3-32	9	9⅞	25c qu. Apr. 25
Alpha P. C. pfd.[2]	9- 3-32	....	85	1.75 qu. Sept. 15
Amalgamated Phos. 6's, '36[19]	8-18-32	89	93	
American Aggregates com.[27]	9- 6-32	1	3	
American Aggregates pfd.[19]	8-18-32	5	15	1.75 qu. Jan. 1
Amer. Aggr. 6's, w.w.[19]	9- 8-32	35	50	
Amer. L. & S. 1st 7's[27]	9- 6-32	50	....	
Arundel Corp. com.	9- 6-32	22 actual sale		75c qu. July 1
Bessemer L. & C. Class A[4]	9- 2-32	....	2	
Bessemer L. & C. 1st 6½'s[4]	9- 2-32	15½	....	
Bloomington Limestone 6's[27]	9- 6-32	No market		
Boston S. & G. new com.[37]	9- 2-32	2	5	5c qu. July 1
Boston S. & G. new 7% pfd.[37]	9- 2-32	20	30	87½c qu. July 1
Boston S. & G. 7's, 1934[19]	8- 1-32	55	60	
California Art Tile, A	9- 2-32	1½	4¼	
California Art Tile, B[9]	9- 1-32	....	4	
Calaveras Cement com.	9- 2-32	....	2¼	
Calaveras Cement 7% pfd.	9- 2-32	....	65	1.75 qu. July 15
Canada Cement com.	9- 2-32	4⅞	5⅛	
Canada Cement pfd.	9- 2-32	33	....	1.62½ qu. June 30
Canada Cement 5½'s[42]	9- 1-32	80	85	
Canada Crushed Stone bonds[42]	9- 1-32	64	70	
Canada Crushed Stone com.[42]	9- 1-32	1	3	
Certainteed Products com.	9- 6-32	2¾	2⅞	
Certainteed Products pfd.	9- 6-32	13	17½	1.75 qu. Jan. 1
Certainteed Products 5½'s	9- 6-32	47 actual sale		
Cleveland Quarries	9- 2-32	....	30	10c qu. Sept. 1
Consol. Cement 1st 6½'s, A[44]	9- 6-32	5	10	
Consol. Cement notes, 1941[27]	9- 6-32	No market		
Consol. Cement pfd.[27]	9- 6-32	No market		
Consolidated Oka Sand and Gravel (Canada) 6½'s[12]	9- 2-32	50	60	
Consolidated Oka Sand and Gravel (Canada) pfd.[42]	9- 1-32	....	50	
Consol. Rock Prod. com.[35]	9- 1-32	5c	15c	
Consol. Rock Prod. pfd.[35]	9- 1-32	40c	60c	
Consol. Rock Products units[35]	9- 1-32	½	1½	
Consol. S. & G. pfd. (Can.)	9- 2-32	....	50	50c qu. Aug. 15
Construction Mat. com.[47]	9- 7-32	1	3	
Construction Mat. pfd.[47]	9- 7-32	3	5	
Consumers Rock and Gravel, 1st Mtg. 6's, 1948[35]	9- 1-32	28	33	
Coosa P. C. 1st 6's[23]	9- 2-32	15	25	
Coplay Cem. Mfg. 1st 6's[47]	9- 7-32	35	40	
Coplay Cem. Mfg. pfd.[47]	9- 6-32	6	8	
Dewey P. C. com.[47]	9- 6-32	75	85	
Dolese and Shepard	9- 6-32	14	16	$1 qu. Jan. 1
Dufferin Pav. & Cr. Stone pfd.[42]	9- 1-32	....	26	1.75 qu. Apr. 1
Dufferin Pav. & Cr. Stone com.[42]	9- 1-32	....	5	
Edison P. C. com.[47]	9- 6-32	3	5	
Federal P. C. 6½'s[47]	9- 7-32	50	60	
Giant P. C. com.[47]	9- 6-32	1	2	
Giant P. C. pfd.[47]	9- 6-32	4	6	
Gyp. Lime & Alabastine, Ltd.	9- 2-32	4	4⅛	
Gyp. Lime & Alabastine 5½'s[42]	9- 1-32	58	65	
Hermitage Cement com.[11]	9- 3-32	3	6	
Hermitage Cement pfd.[11]	9- 3-32	20	30	
Ideal Cement 5's, 1943[47]	9- 7-32	71	74	
Ideal Cement com.	9- 6-32	8	11	50c qu. July 1
Indiana Limestone units[27]	9- 6-32	No market		
Indiana Limestone 6's	9- 6-32	11 actual sale		
International Cem. com.	9- 6-32	14¼	14½	50c qu. Mar. 31
International Cem. bonds, 5's	9- 6-32	71 actual sale		Semi-ann. int.
Kelley Island L. & T.	9- 6-32	11½	12	25c qu. July 1
Ky. Cons. Stone com.[45]	9- 2-32	1	2	
Ky. Cons. Stone 7% pfd.[45]	9- 2-32	10	15	
Ky. Cons. Stone 1st Mtg. 6½'s[45]	9- 2-32	15	18	
Ky. Cons. St. V. T. C.[45]	9- 2-32	1	2	
Ky. Rock Asphalt com.[11]	9- 3-32	1	2	
Ky. Rock Asphalt pfd.[11]	9- 3-32	12	15	
Ky. Rock Asphalt 6½'s[11]	9- 3-32	60	65	
Lawrence P. C.[2]	9- 3-32	11	15	
Lawrence P. C. 5½'s, 1942[2]	9- 3-32	31	....	
Lehigh P. C. com.	9- 6-32	10	11	
Lehigh P. C. pfd.	9- 6-32	65	70	1.75 qu. Oct. 1
Louisville Cement[7]	9- 1-32	60	80	
Lyman-Richey 1st 6's, 1935[18]	9- 2-32	85	95	
Marblehead Lime 6's[14]	9- 2-32	No market		
Marbelite Corp. com.[35] (cement products)	9- 1-32	5c	75c	
Marbelite Corp. pfd.[35]	9- 1-32	50c	....	
Marquette Cement com.[47]	9- 6-32	4	6	
Marquette Cement pfd.[47]	9- 6-32	48	52	1.50 qu. July 1
Marquette Cem. Mfg. 1st 5's, 1936[46]	9- 6-32	70	....	
Marquette Cem. Mfg. 1st 6's, 1936[46]	9- 6-32	75	....	
Material Service Corp.	9- 6-32	4	8	
McCrady-Rodgers 7% pfd.[22]	9- 1-32	20	30	87½c qu. June 30
McCrady-Rodgers com.[22]	9- 1-32	No market		75c qu. Jan. 26
Medusa P. C. pfd.[47]	9- 6-32	40	45	1.50 qu. Apr. 1
Medusa P. C. com.[47]	9- 6-32	6	8	
Monarch Cement com.[47]	9- 6-32	55	60	
Michigan L. & C. com.[6]	8-20-32	45	....	
Missouri P. C.	9- 6-32	....	12	25c qu. Jan. 30
Monolith Portland Midwest com.[35]	9- 1-32	20c	30c	
Monolith Portland Midwest pfd.[9]	9- 1-32	15c	30c	
Monolith P. C. com.[9]	9- 1-32	60c	90c	40c s.-a. Jan. 1
Monolith P. C. pfd.[9]	9- 1-32	1	1¼	40c s.-a. Jan. 1
Monolith P. C. units[9]	9- 1-32	2¼	3¼	
Monolith P. C. 1st Mtg. 6's[9]	9- 1-32	35	40	
National Cem. (Can.) 1st 7's[27]	9- 6-32	75	85	
National Gypsum A com.[27]	9- 6-32	2¾	3¼	
National Gypsum pfd.	9- 6-32	33	36	1.75 qu. Oct. 1
National Gypsum 6's[3]	9- 6-32	70	....	
National L. & S. 6½'s, 1941[27]	9- 8-32	70	75	
Nazareth Cement com.[47]	9- 7-32	3	6	
Nazareth Cement pfd.[47]	9- 7-32	30	35	
Newaygo P. C. 1st 6½'s[27]	9- 6-32	80	90	
New England Lime 6's, 1935[14]	9- 2-32	....	10	
N. Y. Trap Rock 1st 6's	9- 3-32	61 actual sale		
N. Y. Trap Rock 7% pfd.[27]	9- 6-32	....	60	1.75 qu. Oct. 1
North Amer. Cem. 1st 6½'s	9- 6-32	34 actual sale		
North Amer. Cem. com.[27]	9- 6-32	No market		
North Amer. Cem. 7% pfd.[27]	9- 6-32	¾	....	
North Shore Mat. 1st 6's[15]	9- 6-32	40	....	
Northwestern States P. C.[47]	9- 6-32	25	28	
Ohio River S. & G. com.	8-30-32	....	8	
Ohio River S. & G. 7% pfd.	8-30-32	....	98	
Ohio River S. & G. 6's[27]	8- 8-32	17	....	
Oregon P. C. com.[9]	9- 1-32	8	12	
Oregon P. C. pfd.[9]	9- 1-32	80	85	
Pacific Coast Aggr. com.[40]	9- 1-32	....	1	
Pacific Coast Aggr. pfd.[40]	9- 1-32	....	2	
Pacific Coast Aggr. 6½'s, 1944[5]	9- 2-32	10	12	
Pacific Coast Aggr. 7's, 1939[5]	9- 2-32	2	4	
Pacific Coast Cement 6's[5]	9- 2-32	40	....	
Pacific P. C. com.[5]	9- 2-32	1½	3½	
Pacific P. C. pfd.[5]	9- 2-32	26	30	1.62½ qu. July 5
Pacific P. C. 6's, 1934	9- 2-32	80	....	
Pacific P. C. 6's, 1935	9- 2-32	75	94	
Pacific P. C. 6's, 1936	9- 2-32	75	94	
Peerless Cement com.[1]	9- 2-32	20c	60c	
Peerless Cement pfd.[1]	9- 2-32	4	10	
Penn.-Dixie Cement com.	9- 6-32	2	2⅛	
Penn.-Dixie Cement pfd.	9- 6-32	7	12	
Penn.-Dixie Cement 6's	9- 6-32	58⅝ actual sale		
Penn. Glass Sand Corp. pfd.[27]	9- 6-32	40	50	1.75 qu. Apr. 1
Penn. Glass Sand Corp. 6's[19]	8-18-32	70	....	
Petoskey P. C.	9- 6-32	1¼	1½	
Port Stockton Cem. com.[9]	9- 1-32	No market		
Riverside Cement com.[9]	9- 1-32	....	10	
Riverside Cement pfd.[9]	9- 1-32	38	42	1.50 qu. Aug. 1
Riverside Cement, A[9]	8-15-32	4	6	
Riverside Cement, B[9]	9- 1-32	70c	1	
Roquemore Gravel 6½'s[17]	8-20-32	75	....	
Sandusky Cement 6½'s, 1932-37[27]	9- 6-32	70	80	
Santa Cruz P. C. com.	9- 2-32	48	65	$1 qu. July 1
Schumacher Wallboard com.	9- 2-32	1.10	....	
Schumacher Wallboard pfd.	9- 2-32	3	....	50c qu. May 15
Signal Mt. P. C. pfd.[47]	9- 6-32	5	8	
Southwestern P. C. units[47]	9- 6-32	150	175	
Southwestern P. C. com.[47]	9- 6-32	30	40	
Southwestern P. C. pfd.[47]	9- 6-32	70	75	$2 qu. July 1
Standard Paving & Mat. (Canada) com.[42]	9- 1-32	1	2	
Standard Paving & Mat. pfd.[42]	9- 1-32	....	25	50c qu. Aug. 15
Superior P. C., A[9]	9- 1-32	23	25	27½c mo. Oct. 1
Superior P. C., B[9]	9- 1-32	4	6	12½c July 20
Trinity P. C. units[47]	9- 6-32	35	40	
Trinity P. C. com.[47]	9- 6-32	5	8	
Trinity P. C. pfd.[47]	9- 6-32	32	36	
U. S. Gypsum com.	9- 6-32	25¼	26	40c qu. Oct. 1
U. S. Gypsum pfd.	9- 6-32	99	100½	1.75 qu. Oct. 1
Wabash P. C.[21]	9- 2-32	5	9	
Warner Co. com.[27]	9- 6-32	3½	4	
Warner Co. 1st 7% pfd.[27]	9- 6-32	15	20	1.75 qu. Apr. 1
Warner Co. 6's, 1944, w. w.	9- 2-32	37	50	
Whitehall Cem. Mfg. com.[47]	9- 7-32	30	40	
Whitehall Cem. Mfg. pfd.[47]	9- 7-32	40	50	
Wiscon. L. & C. 1st 6's, '33[15]	9- 6-32	25	....	
Wolverine P. C. com.	9- 6-32	¾	3¼	
Yosemite P. C., A com.[9]	9- 1-32	90c	1.10	

*Latest 1932 dividend.

Quotations by: [1]Watling Lerchen & Hayes Co., Detroit, Mich. [2]Bristol & Willett, New York. [3]Rogers, Tracy Co., Chicago. [4]Butler, Wick & Co., Youngstown, Ohio. [5]Smith, Camp & Riley, San Francisco, Calif. [6]Frederick H. Hatch & Co., New York. [7]J. J. B. Hilliard & Son, Louisville, Ky. [8]Dillon, Read & Co., Chicago, Ill. [9]A. E. White Co., San Francisco, Calif. [10]Lee Higginson & Co., Boston and Chicago. [11]J. W. Jakes & Co., Nashville, Tenn. [12]James Richardson & Sons, Ltd., Winnipeg, Man. [13]Stern Bros. & Co., Kansas City, Mo. [14]First Wisconsin Co., Milwaukee, Wis. [15]Central-Republic Bk. & Tr. Co., Chicago. [16]G. M. P. Murphy & Co., Baltimore, Md. [17]Citizens Southern Co., Savannah, Ga. [18]Dean, Witter & Co., Los Angeles, Calif. [19]Hewitt, Ladin & Co., New York. [20]Tucker, Hunter, Dulin & Co., San Francisco, Calif. [21]Baker, Simonds & Co., Inc., Detroit, Mich. [22]Peoples-Pittsburgh Trust Co., Pittsburgh, Penn. [23]Howard R. Taylor & Co., Baltimore. [24]Richards & Co., Philadelphia, Penn. [25]Hincks Bros. & Co., Bridgeport, Conn. [26]Bank of Republic, Chicago, Ill. [27]National City Co., Chicago, Ill. [28]Chicago Trust Co., Chicago, Ill. [29]Boettcher-Newton & Co., Denver. [30]Hanson and Hanson, New York. [31]S. F. Holzinger & Co., Milwaukee, Wis. [32]Tobey and Kirk, New York. [33]Steiner, Rouse and Co., New York. [34]Jones, Heward & Co., Montreal, Que. [35]Tenney, Williams & Co., Los Angeles, Calif. [36]Stein Bros. & Boyce, Baltimore, Md. [37]Wise, Hobbs & Arnold, Boston. [38]E. W. Hays & Co., Louisville, Ky. [39]Blythe Witter & Co., Chicago, Ill. [40]Martin Judge Co., San Francisco, Calif. [41]A. J. Pattison Jr. & Co. Ltd., Toronto, Canada. [42]Nesbitt, Thomson & Co., Toronto. [44]E. H. Rollins, Chicago. [45]Dunlap, Wakefield & Co., Louisville, Ky. [46]First Union Trust & Savings Bank, Chicago. [47]Anderson Plotz and Co., Chicago, Ill. [48]Hemphill, Noyes and Co., New York City.

Bondholders of Bessemer Cement Organize

FOLLOWING UP the default on the interest on its bonds August 1, bondholders of the Bessemer Limestone and Cement Co. have organized a protective committee to work out the financial affairs of the company.

Announcement of this action was made by William R. Daley of Otis and Co., Cleveland, Ohio, who has been appointed chairman of the committee. Other members are: Col. Frank A. Scott, fiscal director of Western Reserve University; R. C. Steese, director of the Union National Bank and the Sheet and Tube Co. of Youngstown; John R. Rowland, president of the Mahoning National Bank, Youngstown, and John W. Ford, attorney, also of Youngstown.

Bessemer's trouble is but another incident in the depression which has hit the steel and building business. The company owns large limestone quarries in Pennsylvania and supplies fluxing stone to the steel industry, and crushed limestone to builders and also for the manufacture of cement.

According to a letter sent out by the committee recently to bondholders, the default in interest was due to a decline in the volume and price of the company's product. "It is hoped," says the letter, "that the affairs of the company can be worked out without the necessity of a reorganization, merger or sale of the assets."

The Bessemer company began the production and distribution of limestone in 1887 and went into the cement business in 1920. The property of the company was appraised in 1926 at more than $5,000,000 and since that date, according to the committee, more than $1,000,000 has been spent on additions.

At the first of the year the company had outstanding $2,177,400 of 20-year 6½% first mortgage bonds due February 1, 1947; 50,000 shares of Class A stock of a declared value of $1,500,000; 100,000 shares of Class B stock of a declared value of $2,000,000, and a surplus of $42,251 in its treasury.

The holders of the bonds are requested by the committee to have them deposited with the Dollar Savings and Trust Co., Youngstown, or the Guardian Trust Co., Cleveland, by September 15.

Trinity Portland Cement

THE Trinity Portland Cement Co., Dallas, Tex., reports for the year ended December 31, 1931, that operations of the company for the past year, notwithstanding a substantial road program in the state were very definitely curtailed. Building of every character was and is practically at a standstill. With the reduced demand, competition for the existing volume became so intense that the price structure was not only materially reduced but became badly demoralized. Some profit was made in the first half of the year—enough to justify payment of regular semi-annual dividends on preferred stock.

The price structure in connection with the 23c. tariff now practically precludes the importation of any cement at the Gulf ports.

All plants were again operated without fatal injury. The Fort Worth plant was operated for the second consecutive year without a lost-time accident.

ASSETS		
Current assets and investments		$1,034,078.03
Inventories		829,816.52
Prepaid expenses		18,989.69
Plant property and equipment		7,171,183.57
		$9,054,067.81
LIABILITIES		
Capital stock		$3,500,000.00
Deferred liabilities:		
Bonds outstanding	$650,000.00	
Term notes	300,000.00	950,000.00
Surplus		3,988,606.84
Current notes and accounts		569,805.84
Reserve for current expenses		45,655.13
		$9,054,067.81

Arundel Net Profit

THE Arundel Corp., Baltimore, Md., sand and gravel producer and dredging contractor, reports for six months ended June 30, 1932, net profit $747,311 after depreciation, federal taxes, etc., equal to $1.51 a share on 492,556 no-par shares of capital stock. This compares with $1,127,020 or $2.29 a share in first six months of 1931.

June net profit was $146,718 after charges and federal taxes, against $255,914 in June last year.

Current assets as of June 30, 1932, amounted to $3,873,358 and current liabilities were $491,000, comparing with $4,072,570 and $350,919 respectively at end of June, 1931.

Canada Cement Omits Preferred Dividend

AN OFFICIAL statement by J. D. Johnson, president of the Canada Cement Co., Ltd., Montreal, Que., announces: "At a meeting of the board of directors of this company, held August 27, it was decided to defer payment of the cumulative preference dividend for the quarter ending August 31, 1932.

"The prolonged depression in general business, and particularly in the building industry, has materially affected the demand for the company's product, and consequently the operations of its plants and sales of cement have been on a considerably reduced scale during the present season. While the directors regret having to postpone dividend payments, it is felt that it is in the best interests of the shareholders to do so in order to maintain the liquid position of the company.

"Any marked change for the better in general business conditions would probably soon be reflected in increased building activity and a consequent improvement in the company's sales. The plants of your company have been kept in an efficient condition and rigid economies have been effected wherever possible in all departments, so that your company is in excellent position to take advantage of any return to more prosperous conditions."

Commenting on this announcement, the *Financial Post* (Toronto, Ont.) says:

"Since the present company came into being in 1927 the preferred stock dividend has been earned by a comfortable margin. For the first 11 months of operations, share earnings were equivalent to $6.64 as against dividends of $6.50 a share. In the three succeeding years earnings on the preferred ranged from $7.41 to $7.62 a share.

"This is the first time in 22 years that Canada Cement has failed to pay dividends on its preferred stock. From 1910 to 1927 the old company regularly paid 7% on its senior stock. The new company met the charges promptly up until this time.

"No reference is made in the current statement as to earnings. The fact that plant operations have been considerably curtailed presupposes a corresponding drop in revenues. It is stated that all departments of the Port Colborne plant will reopen at the beginning of September, after being closed down for several months. The entire plant will be in operation about September 5, employment being given to several hundred workmen. Production will be stored in anticipation of the spring demands.

"With the news of the passing of the dividend, the preferred stock broke 13 points to 75. It had been selling in the late 30's for some time."

Directors of Monolith Fight Receivership Application

DIRECTORS of the Monolith Portland Cement Co. have laid plans to fight a suit brought by stockholders seeking a receivership and recovery from officers and directors of the company of approximately $250,000 which the stockholders claim was spent illegally.

The suit also seeks recovering of stock in the cement company valued in excess of $1,000,000 and now held by the Monolith corporation.—*Los Angeles* (Calif.) *Herald.*

Recent Dividends Announced

Alpha Portland Cement pfd. (qu.)	$1.75	Sept. 15
Johns-Manville pfd. (qu.)	1.75	Oct. 1
National Gypsum pfd. (qu.)	1.75	Oct. 1
New York Trap Rock $7 pfd. (qu.)	1.75	Oct. 1
Wallace Sandstone Quarries, Ltd., pfd. (s.-a.)	1.50	Oct. 13

Sinking Fund Notice

Issue	Amount available	Not over	Last day
McCrady-Rodgers Co. (Pittsburgh) 7% cum. pfd.	$25,000	55	Sept. 20, 1932

Traffic and Transportation

Proposed Changes in Rates

THE following are the latest proposed changes in freight rates up to the week ending September 3:

TRUNK LINE ASSOCIATION DOCKET

29705. **Broken stone,** carloads (See Note 2), from Lambertville, N. J., to Belmar, N. J., $1.04 per 2000 lb. (See Note 4).

29707. **Sand,** other than blast, engine, foundry, molding, glass, silica, quartz or silex, carloads, also **gravel,** carloads (See Note 2), from Patapsco, Md., to White Plains, Md., 85c per net ton (See Note 3).

29720. **Crushed stone** (not coated), carloads (See Note 2), from Montclair Heights, N. J., to Ramsey, N. J., 80c; Port Jervis, N. Y., $1.10; Shohola and Lackawaxen, Penn., $1.20; Hawley, Penn., $1.30, and Saco, Penn., $1.40 per net ton. (See Note 4.)

29724. **Sand,** carloads (See Note 2), from South Pemberton and Birmingham, N. J., to Beach Haven, N. J., $1.27 per net ton. Reason—Proposed rate is comparable with rate to Ship Bottom, N. J.

29726. **Sand,** other than blast, engine, foundry, glass, molding or silica, and **gravel,** carloads (See Note 1), from Machias, N. Y., to Mill Village, Penn., $1.30 per net ton (See Note 4).

29727. **Crushed stone,** carloads (See Note 2), from White Haven, Penn., to Centralia, Penn., 90c per net ton (See Note 4).

29736. **Crushed stone, crushed stone screenings, crushed stone tailings** (not coated), (See Note 2) from LeRoy, N. Y., and Lime Rock, N. Y., to Bingham, Penn., $1.10 per net ton (See Note 4).

29744. **Stone chips or granules,** carloads, minimum weight 50,000 lb., from Blue Mount, Md., to New York, N. Y., $3.06; Philadelphia, Penn., $2; Baltimore, Md., $1, and Washington, D. C., $1.40 per net ton. Reason—Proposed rates are fairly comparable with rates from Texas and Cockeysville, Md.

29754. **Crushed stone and screenings,** carloads (See Note 2), from Calcite, Penn., to Barnesboro, Windber, Clearfield and Mahaffey, Penn., $1 per net ton. (See Note 4.)

29756. **Crushed stone,** carloads (See Note 2), from White Haven, Penn., to Lake Ariel, Penn., $1.20 per net ton. Present rate, $1.60. (See Note 4.)

M-3090. **Stone, natural** (other than bituminous asphalt rock), **crushed,** carloads, from Le Roy, N. Y., to Cedar Ledge, Penn., $1.50 per net ton.

29767. **Stone, natural** (other than bituminous asphalt rock), **crushed,** carloads (See Note 2), from Tompkins Cove, N. Y., to Harriman, N. Y., $1, and Oxford and Monroe, N. Y., $1.10 per net ton. Present rate, $1.40. (See Note 4.)

29768. **Sand,** other than blast, engine, foundry, molding, glass, silica, quartz or silex, carloads (See Note 2), from Morrisville, Penn., to Betzwood, Penn., 80c per net ton. Present rate, $1. (See Note 4.)

29777. **Crushed stone,** carloads (See Note 2), from Bethlehem, Penn., to stations on the L. V. R. R. Rates ranging from 80c to $1.30 per net ton. (See Note 4.)

29778. **Stone, crushed or ground, or quarry broken,** carloads (See Note 2), from Jamesville, N. Y., to Fassett, Gillett, Dunning, Snediker, Columbia Cross Roads, Tin Bridge, Troy, Cawley, Alba, Canton, Cedar Lodge and Grover, Penn., $1.60, and Leolyn, Penn., $1.70 per net ton. (See Note 4.)

29779. **Ground limestone,** carloads, minimum weight 50,000 lb., from Munns, N. Y., to L. V. R. R. stations. Rates ranging from 95c to $1.70 per net ton. (See Note 4.)

CENTRAL FREIGHT ASSOCIATION DOCKET

32654. To establish **stopping in transit privileges on ground limestone,** in bulk or in bags, at stations located on the C. I. & L. Ry., for the purpose of unloading. Proposed stop-off charge, $6.30 per car. Present—No stopping in transit privileges in effect.

32656. To establish on crushed stone, carloads, from Sandusky, O., to Willard, O., rate of 40c per net ton, plus emergency charge. Present—50c, plus emergency charge.

32657. To establish on **sand and gravel,** in open top cars, carloads, from Columbus, O., to Marion, O., rate of 70c per net ton (emergency charge in addition) via C. C. C. & St. L. Ry. Present—90c.

32658. To establish on **crushed stone** (in bulk), rough (not dimension or dressed), **rubble, rip rap, quarry strippings and limestone, unburned agricultural** (in bulk, in open top cars only), carloads, from Kankakee, Lehigh Vans' Siding and West Kankakee, Ill., to Buchanan, Three Oaks and Niles, Mich., rate of 95c per net ton. Present—101c.

32744. To establish on **sand and gravel,** carloads, in open top equipment (See Note 3), from Warwick, O., to Mt. Vernon, 95c; New Comerstown, 100c; Cambridge, 115c per net ton (emergency charge not included). Present, 120c to Mt. Vernon, 110c to New Comerstown, 130c per net ton to Cambridge, O. (emergency charge not included).

Note 1—Minimum weight marked capacity of car.

Note 2—Minimum weight 90% of marked capacity of car.

Note 3—Minimum weight 90% of marked capacity of car, except that when car is loaded to visible capacity the actual weight will apply.

Note 4—Reason—Proposed rates are comparable with rates on like commodities for like distances, services and conditions.

32832. To establish on **sand** (except blast, core, engine, filter, fire or furnace, foundry, glass, grinding or polishing, loam, molding or silica) and **gravel,** in open top cars, carloads (See Note 3), from Ashtabula and Ashtabula Harbor to Mather, Penn., rate of 160c per net ton. Route—Via N. Y. C. R. R., Youngstown, O., P. & L. E. R. R., Brownsville Jct., Monongahela R. R. Present—20c (sixth class).

32833. To establish on **stone, lake or river filling** (offal of quarry), carloads, all cars to be loaded to cubical or visible capacity, from Amherst, O., to Andover, O., rate of 100c per net ton. Present—126c.

32872. To establish on **stone sand,** carloads, from Piqua, O., to South Bend, Ind., rate of 180c per net ton. Present—227c.

32873. To establish on **crushed stone,** carloads, from Keeport, Ind., to Paulding, O., rate of 110c per net ton, plus emergency charge. Route—Via Wabash Ry., Cecil, O., Cin. Nor. Ry. Present—150c, plus emergency charge.

32874. To establish on **waste stone,** viz., breakwater, chip, grout, rip rap and spauls, in straight or mixed carloads, in open top equipment, from I. C. R. R. stations, viz., Bloomington, Clear Creek, Quarry Jct., Dodgson and Victor, Ind., to Springfield, Ill., rate of 119c per net ton, plus emergency charge. Present—139c per I. C. R. R. Tariff No. 793-K.

32875. To establish on **gravel,** carloads, to Danville, Que., from East St. Louis, Ill., and St. Louis, Mo., rate of $9 per net ton. Present—58c (classification basis).

32905. To establish on **slag, crude, granulated, crushed or commercial,** in bulk, in open top equipment, in straight or mixed carloads, from Hamilton, O., to points in Indiana and Louisville, Ky. (representative points in Indiana shown below), (rates in cents per net ton):

To	Prop.	Pres.	To	Prop.	Pres.
Woodford	75	260	Indianapolis	105	300
Decatur	105	340	Lebanon	115	340
Union City	100	280	Franklin	115	300
Marion	110	340	Austin	120	340
Muncie	105	300	Shelbyville	105	280
New Castle	90	260	Middle Fork	120	340
Kokomo	110	340			

32906. To establish on **crushed stone** (in bulk, in open top cars), carloads, minimum weight, from Holland, O., to Swanton, Delta, Wauseon, Pettisville, Archbald, Stryker, Bryan, Melbern, Mina and Edgerton, O., rate of 50c per net ton, subject to emergency charge. Present—60c to Swanton, Delta, Wauseon, Pettisville, Archbald and Stryker, and 70c per net ton to Bryan, Melbern, Mina and Edgerton, O.

WESTERN TRUNK LINE DOCKET

7283-1. **Sand (river) and gravel,** carloads (See Note 3), from Pacific, Jedburg and Yeatman, Mo., to Illinois points within the radius of 115 mi., from East St. Louis, Ill. Rates: Present—Combination. Proposed—Distance scale of rates, of which the following is representative, using the average distance from the above origin points to St. Louis, Mo. This scale represents the I. C. C. Docket 17000, part 11-A scale, plus 28c per ton, river transfer. Rates in cents per ton of 2000 lb.

Distance in miles.	
10 miles and under	93
50 miles and over 40	117
100 miles and over 90	143
150 miles and over 140	168

8098. **Stone, rock, rip rap and limestone, crushed** (See Note 3). In no case shall the minimum weight be less than 40,000 lb., from Weldon Springs, Mo., to Chicago, Joliet, Peoria and Pekin, Ill. Rates:

To	Pres.*	Prop.*	To	Pres.*	Prop.*
Chicago	283†	190	Peoria	210‡	145
Joliet	283†	180	Pekin	210‡	140

*Does not include emergency charge of 6c a ton.
†Based on St. Louis combination.
‡Based on Alton, Ill., combination.

496-T. **Limestone, agricultural, ground or pulverized,** in bags, barrels or in bulk, for soil treatment, carloads (See Note 2), from Louisville, Neb., to C. B. & Q. R. R. stations in Northwest Missouri and Wabash Ry. stations in Missouri as far south as Conception, Mo. Present rates, same as applicable on sand, gravel or stone, which figures approximately ½c to 3½c per 100 lb. higher than proposed rates. Proposed rates (in cents per ton of 2000 lb.):

Mi.	Rate	Mi.	Rate
40	59	150	115
50	63	160	119
60	67	170	123
70	71	175	125
80	76	180	127
90	82	190	131
100	88	200	135
110	96	210	138
115	99	220	141
120	102	225	144
130	107	230	144
140	111	240	147
145	113	250	150

Sup. 1 to 8049. **Slag, ground, or slag, ground, and limestone, ground, mixed,** from Buffington, Ind., to Minneapolis and St. Paul, Minn., and Kansas City, Mo. Please refer to Docket Bulletin No. 3253, July 21, 1932, Docket 8049. This subject has now been withdrawn from the docket at request of proponent.

Sup. 1 to 1873-O. **Chatt** (mine gravel, whole or crushed); **stone, crushed** (broken stone ranging in size up to 200 lb. in weight); **gravel; sand** (except asbestos sand and silica sand), between points in Kansas on intrastate traffic only for single line movement. Please refer to Docket Bulletin No. 3271, August 15, Docket 1873-O. This subject has now been withdrawn from the docket, same being covered by Emergency Proposal 51-16.

ILLINOIS FREIGHT ASSOCIATION DOCKET

3883-C. **Sand (river) and gravel,** carloads, from Pacific, Jedburg and Yeatman, Mo., to Illinois points within the radius of 115 mi. from East St. Louis, Ill. Rates in cents per net ton:

10 miles and under	93
20 miles and over 10	99
30 miles and over 20	105
40 miles and over 30	111
50 miles and over 40	117
60 miles and over 50	123
70 miles and over 60	128
80 miles and over 70	133
90 miles and over 80	138
100 miles and over 90	143
110 miles and over 100	148

6757. **Sand and gravel,** carloads (See Note 3), from Allison Branch, Ill., to various I. R. C. points. To representative points in Illinois (rates in cents per net ton):

To	Pres.	Prop.	To	Pres.	Prop.
Boyleston	113	100	Ellery	(*)	100
Idlewood	113	113	Mt. Carmel	(*)	105
Hoffman	(*)	120			

*Classification basis.

6761. **Lime rock, or limestone, broken, crushed or ground,** carloads, minimum weight less than marked capacity of car, but not less than 40,000 lb., from Mosher, Mo., to Freeport, Ill. Present rate, $2.28 per ton; proposed, $2.05.

6795. **Silica sand**, carloads (See Note 2), but not less than 60,000 lb., from Crystal City, Mo. (Sand Pit, Mo.), to Mt. Vernon, Ill. Present, combination of locals; proposed, $1.25 per ton.

6800. **Sand and gravel**, carloads (See Note 3), from Allison Branch, Ill., to various representative points in Illinois (rates in cents per net ton):

To	Pres.	Prop.	To	Pres.	Prop.
Brubaker	*	113	Dollville	*	126
Baxter	*	113	Kelly	*	113
Shelbyville	*	126	Marion	*	126

*Classification basis.

6807. **Silica sand**, carloads (See Note 2), from Ottawa-Utica district to New Athens, Ill. Present rate, $2 per net ton; proposed, $1.75.

Proposed I. C. C. Decisions

24987. Plaster Retarder. Standard Gypsum Co., Inc., et al. vs. A. T. and S. F. et al. By Examiner Haden. Recommends that commission find rates, plaster retarder, McCook, Ill., to Los Angeles and Long Beach, Calif., and Ludwig, Nev., were, are and for the future will be unreasonable to the extent they exceeded, exceed or may exceed 80.5 c., minimum 60,000 lb., and award reparation.

I. C. C. Decisions

24911. Crushed Marble. Builders' Association of Kansas City, Mo., Inc., vs. L. & N. Dismissed. Rate of crushed marble or marble chips, also known as marble terrazzo material, Tate, Ga., to New Orleans, La., not unreasonable or otherwise unlawful.

24691. Sand. Nixon and Phillips vs. I. C., dismissed. Rate and switching charge, sand, Memphis, Tenn., to Red Bay, Ala., was held applicable.

3642. Crushed Stone Switching. Absorption of switching charges on crushed stone at St. Joseph, Mo. Proposed restriction of amount of switching charges to be absorbed, crushed stone, from St. Joseph Quarries Co. within the switching limits of St. Joseph, Mo., to interstate destinations, justified. Order of suspension vacated, and proceeding discontinued.

19943. Lime and Ground Limestone. Sub-No. 1, North American Cement Corp. vs. A. & R. et al. (Second report on further hearing.) Findings in first report on further hearing, 163 I. C. C. 701, modified so as to authorize addition of emergency surcharges to rates therein prescribed on lime and ground limestone. Original report, 153 I. C. C. 431. Order of June 9, 1932, amended accordingly. The question as to the applicability of the emergency charge arose in connection with the refusal of the Virginia commission to allow the surcharge to be imposed upon intrastate traffic. This report affirms the former findings of undue prejudice and preference affirmed and finds that uniform addition of the surcharge to the intrastate rates is necessary to prevent the undue prejudice and preference. New rates in accordance with the report are to be made effective not later than August 27.

14460. Asphalt Rock and Limestone. In a report by division 2 in Petition in Fourth Section Application No. 14460, asphalt rock and limestone in the southwest, the commission, in supplemental fourth section order No. 10713, has modified and amended fourth section order No. 10713, entered August 28, 1931, so as to provide that in instances where the use of a rule showing rates and maximum distances, in lieu of specific routing, similar to that approved in Brick and Clay Products in the South, 113 I. C. C. 380, is authorized, the relief shall apply over such routes even though in some instances the degree of circuity which would result from the establishment of rates in accordance with such rule may exceed the degree of circuity authorized in paragraph 3 of order No. 10713. The order applies to rates on asphalt rock, natural or coated, and stone coated with not to exceed 5% of road oil, crushed or ground, containing not more than 6% of asphalt, between points in Arkansas, Kansas, Louisiana (west of the Mississippi river), Baton Rouge, New Orleans and sub-ports; Y. & M. V. R. R. stations north of Baton Rouge to New Orleans, inclusive; Louisiana and Arkansas stations, Angola to New Orleans, inclusive, Missouri, Oklahoma and Texas; also from Margerum and Cherokee, Ala., to points in Arkansas, Kansas, Louisiana, west of the Mississippi river, Missouri, Oklahoma and Texas.

14508. Plaster and Barge-Truck Service. Authority to establish reduced rates on plaster and plaster articles, minimum 50,000 lb., from Akron, Clarence Centre, Oakfield and Wheatland, N. Y., to Atlantic coast terminals without observing the long-and-short-haul provision of section 4 has been denied by the commission in a report by division 2 in Fourth Section Application No. 14508, plaster and plaster articles, New York to seaboard. The application was denied in Fourth Section Order No. 11015. Charges ranging from 13.3 to 14.3 c. per 100 lb. would have resulted from the proposal.

As a ground for relief, said the commission, applicants relied on the competition of trucks from the plaster plants to the New York State Barge Canal and barges operating on the canal and the Hudson River beyond. It said there was no movement of plaster or plaster blocks by truck and barge until late in 1931 and that, consequently, the experience of one shipper who used that form of service in the movement of plaster and gypsum blocks from Wheatland was very limited, although that shipper stated that the traffic was well adapted to transportation by water, and that the service was satisfactory. The largest shipper of these articles, however, the commission said, stated that the canal route was impracticable because of damage in transit to the blocks and bags, warehousing and trucking expense at destination and the refusal by the trade of shipments aggregating 300 to 500 tons.

The commission pointed out that the application, filed September 30, 1931, contained the statement that the reduced rates were proposed "in order to meet the competition of the boat lines operating via the barge canal." It would be observed, continued the commission, that from the evidence that prior to that date only one barge load of plaster had moved by way of the canal. It said the season of canal navigation was of about seven months' duration and that during the closed season it would be necessary for shipments to move over all-rail routes. It said there was no evidence of shipments moving by truck and canal except from Wheatland. It set forth a table showing that 7081 tons of plaster and gypsum blocks had moved from Wheatland by truck and barge in 1931.

Four companies which manufacture plaster or plaster blocks at Wheatland, Akron and Clarence Centre favored the relief. The report said the Wheatland producer expected to be able to make shipments by way of the canal in 1932 at a cost not exceeding $2.50 a net ton. In its conclusions, the commission said:

The United States Gypsum Co., one of the largest shippers of these commodities from western New York, has a plant at Oakfield from which it ships substantial quantities of plaster block to the New York metropolitan area, and plaster to the intermediate territory. This company and two other companies, all of which manufacture plaster in or near the New York area, are opposed to the relief sought. They contend that the real purpose of the reduced rates is to meet the competition of producers in that area and that there are no conditions which warrant a reduction in rates to the terminals which are not present at intermediate points. They state that the present rates have not prevented the free movment of the traffic; that the general elimination in building construction is responsible for the decrease in the volume of this traffic; and that the only effect of the reduced rates would be a needless depletion of applicants' revenues. The Oakfield producer states that while it is feasible to move plaster and related articles by truck and water, it has found after investigation that the cost thereof, all things considered, is in excess of the rail rate; and that it has barges in New York harbor which it would use in handling shipments from Oakfield to New York if that were economical. It urges that the estimates of truck and canal costs here of record are too low and are not all inclusive; that the traffic can not be handled by water at a cost so low that it would warrant applicants in reducing the rates as proposed; and that the unusual conditions shown to have obtained on the canal resulting in the distress of certain operators should not be made the basis for a permanent rate adjustment.

Summing up the evidence it appears that transportation of the traffic here considered by truck and canal instead of by all-rail routes has not been generally regarded as practical and economical. While a relatively small proportion of the traffic has moved from one point of origin in that manner, the circumstances surrounding the movement were clearly abnormal. Assuming a recurrence of such conditions during the season of canal navigation, it does not appear that they would attract sufficient tonnage to justify the relief which would be necessary to make effective the substantial reductions in the rates to the terminals here proposed. Those reductions, if applied to the volume of all-rail plaster tonnage which moved from all the points in 1931, would total about $80,000. If the 7081 tons of this traffic which moved over the canal route from Wheatland in that year had moved over applicants' routes, it would have yielded gross revenue of about $24,000.

Oppose Railroads in Move to Fight Barge Lines

APPLICATIONS by railroads seeking to reduce their freight rates on one day's notice without a hearing before the Interstate Commerce Commission have been protested by the Mississippi Valley Association.

Such reductions would destroy barge lines operating on the Mississippi and Ohio rivers, placing the railroads in a position to eliminate all inland waterway transportation, according to Lachlan MacLeay, executive vice-president of the association.

"Barge lines could not meet proposed rail cuts, which would result in such cities as St. Louis, Chicago, Cincinnati, Memphis and New Orleans being deprived of barge line service," he said.

Others that have joined the association in its fight against the proposed cuts include the Lehigh Portland Cement Co., Republic Steel Co., the Mississippi Barge Co. and privately owned barge line companies.—*Macon* (Ga.) *News.*

Foreign Abstracts and Patent Review

Significance of Limestone Structure for Burning. Max Pulfrich finds in testing three limestones, all of high chemical purity and having an identical finishing burn temperature of around 1100 deg. C., that in spite of this similarity they differ considerably from each other regarding properties of the burned lime.

Limestone	A	B	C
Loss on ignition	44.0%	43.9%	43.9%
Insoluble in acid	traces	....	....
Soluble in acid (silicic acid, alumina, iron oxide)	traces	traces	0.15%
Magnesium oxide	0.1%	traces	0.1%

The values obtained for the loss of ignition correspond to the theoretical carbon dioxide content of pure calcium carbonate (44 parts carbon dioxide and 56 parts calcium oxide by weight). Limestone A was a yellowish gray-white fine-granular limestone of rather porous character. Limestone B was fine-crystalline and solid. Limestone C was exceptionally fine-granular, therefore dense and solid, and showed a fragmented shell-like fracture. Boiling in water showed a water absorption ability of 4% for limestone A, 2% for B, and 0% for C.

In the tests, burning temperatures of 900, 1000, 1100, 1200, 1300 and 1400 deg. C. were used. The limestones were crushed to about nut-size, predried and burned simultaneously in the same gas kiln under identical conditions.

All the burned limes were white in color, but otherwise entirely different in their physical appearance and structure. The product of limestone A yielded distinctly mellow, mealy burned lime, while B and C gave a solid burned lime, but C tended to burst while burning. This behavior in burn was also observed on coarse pieces of limestone used in practice.

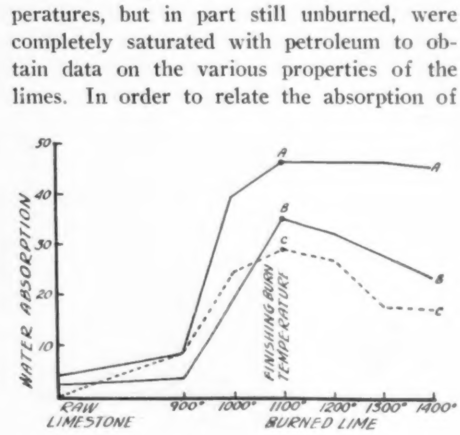
The limes produced at the different temperatures, but in part still unburned, were completely saturated with petroleum to obtain data on the various properties of the limes. In order to relate the absorption of petroleum to the values for water absorption of the raw limestone the values obtained in saturating the burned lime with petroleum were recalculated, making allowance for the difference in specific gravity. The liquid absorption of the burnt lime in per cent. weight was as follows:

Stage of burn, degree C.	900	1000	1100	1200	1300	1400
Limestone A	8	39	46	46	46	45
Limestone B	3	19	35	32	27	23
Limestone C	8	24	29	27	18	17

The curves in an accompanying illustration show the above figures combined with the figures of water absorption ability of the raw limestones. They show that the porous limestone A yields a burned lime of unusual porosity at low temperatures, whereas the burned limes B and C are more dense.

A corresponding view was obtained in reference to the mechanical strength of the burned lime obtained at the finishing burn temperature. Burned lime C was considerably more solid than B and this in turn was considerably more solid than A. The dense burned lime C was also more stable in storage in air than the porous burned lime A. Based on 5 kg. burned lime, production of putty required 12.8 liter of water for A, 16.3 liter for B and 15.1 liter for C.

The test results obtained with the three limestones of identical chemical characteristics and finishing burn temperature show that owing to their diverse structural nature and the diverse properties of the burned limes produced they have entirely different values. Of the three kinds, limestone B is the most valuable for lime production.



Water absorption, in per cent. by weight, of limestone and burned lime

Free Lime in Portland Cement Clinker. Since investigations concerning the action of free CaO in portland cement clinker on the properties of cement have been made mostly with laboratory clinker, Goffin and G. Mussgnug decided to investigate more closely the relations between free lime, volume stability and strength in pure commercial cement clinker (instead of laboratory clinker) and fix them in figures; also to learn whether the determination of the free lime is of use in practical operation and whether the knowledge of the content of free lime admits of further conclusions as to the properties of the clinker, the process of preparation, and the process of burning.

Fresh rotary kiln clinker was used and the free CaO determined qualitatively by the White micro-chemical method and quantitatively by the ammonium-acetate method. The following conclusions were reached

Between free lime and volume stability there is a close relation in portland cement clinker. The fresh ground clinker passes the specifications for volume stability up to 2% free CaO. A greater content of free lime is detrimental to strengths, especially tensile strength. Some decrease in tensile strength is shown in the pure clinker at 1.5% CaO and above. The compressive strengths of clinker containing up to 4.8% free lime show a small increase after 1, 2 and 3 days, but after 7 and 28 days water storage they show a decrease with increasing free lime content. By grinding into it 30% slag sand the strengths of various clinkers with a lime content still above 2%, could be improved in some test periods.

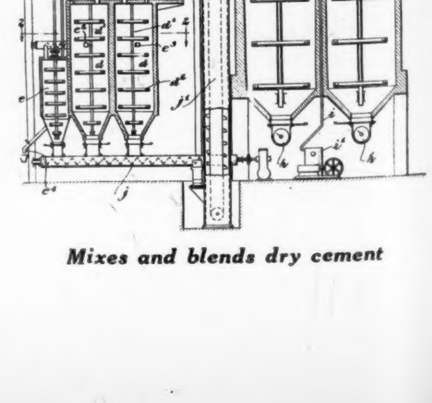
The amount of change can be calculated from the chemical composition and the per cent content of free CaO. The determination of the HC1 insoluble is not sufficient for determining the degree of change.—*Zement* (1932) **21**, 11, pp. 145-148; 13, pp. 178-180.

Recent Process Patents

The following brief abstracts are of current process patents issued by the U. S. Patent Office, Washington, D. C. Complete copies may be obtained by sending 10c to the Commissioner of Patents, Washington, D. C., for each patent desired.

Dry Process for Manufacture of Cement. This patent covers a process for mixing and blending ground dry cement raw materials by stirring them mechanically and injecting air into the powdered mass at the same time. The ground materials are brought to bins by the conveyors (*a* and *a*) shown over the bins at the left. From these the materials are fed into the mixing bins below.

Each mixing bin has a stirring shaft with arms of pipe and are connected through the shaft to an air compressor. Holes at the ends of the arms admit compressed air as

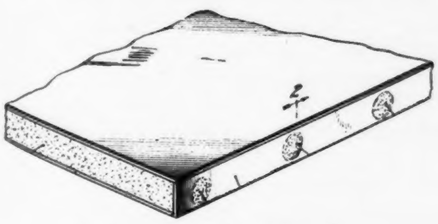


Mixes and blends dry cement

the mass is being stirred. The stirred mixture of air and material is said to be homogenized. If the device is to be used for mixing two components of different composition, each may be homogenized separately.

After being homogenized the materials are delivered to either or both of the large bins shown at the right. These have the same stirring and aerating arrangements as the smaller mixing bins. From the large bins the materials go to the kilns. The small bin (*e*) at the left is a sampling bin arranged so that portions of the materials going to the larger bins may be taken out from time to time and mixed to make a sample that will show what mixture is being made.—*Mikael Vogel-Jorgensen, Denmark, Assignor to F. L. Smidth and Co., New York, U. S. Patent No.* 1,798,423.

Plaster Board. The subject of this patent is a novel method of making the edges. The lower paper, after being folded on the edges in the usual way, is punched so that

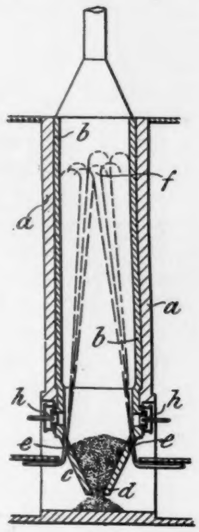


Perforates and rivets edge

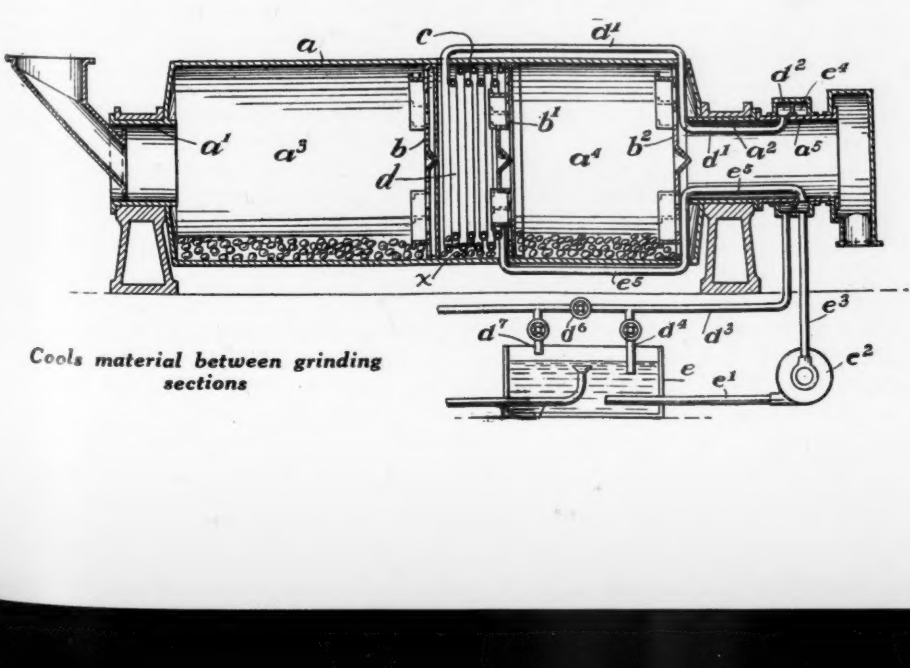
some of the plaster may come through. This forms a "head" like that of a countersunk rivet which holds the strip firmly. The inventor claims that with the trip held in this way it is not necessary for it to be folded over the top of the board to lie under the cover sheet.—*C. W. Utzman, Assignor to the United States Gypsum Co., Chicago, U. S. Patent No.* 1,824,245.

Grinding Mill. This mill is a two-compartment ball mill with a cooling compartment between the two grinding compartments. This cooling compartment consists of a nest of pipes through which cold water is circulated. The inventor claims that cooling the material considerably increases the efficiency of the mill. It also prevents the conversion of gypsum to plaster of paris when the mill is used for grinding gypsum with portland cement clinker.—*Michael Treschow, Assignor to F. L. Smidth and Co., New York, N.Y., U.S. Patent No.* 1,831,049.

Manufacture of Cement and the Like. The process covered by this patent is that of spraying cement slurry into a vertical kiln with force enough to carry it to such a height that in falling back against the upward flow of the heated gases it will have time to be calcined to clinker. Several constructions are shown, but that which is especially mentioned has two slurry jets on opposite sides of the kiln shaft. These are set between oil or powdered coal burners, a pair for each side. The clinker falls to a compartment at the base of the kiln, from which it may be removed in any convenient way. Some cuts show the air for carrying and burning the powdered coal being drawn through the hot clinker compartment in order to preheat it. The slurry jets are located so that the slurry in rising does not come in contact with the flame but falls through it in descending to the clinker compartment. The paper says that "by adjusting the air velocities in the kiln, combined with the adjustment of the degree of atomization of the slurry, it is possible to keep the particles in suspension until the real density attains 3.1 and the apparent density is sufficient to cause the particles to drop, their conversion to clinker being then complete." Waste heat boilers may be used with this form of kiln. The invention is said to be applicable to lime burning. Advantages claimed by the inventor are that the clinker is of a small size which reduces the cost of grinding, and that there is no dust formed by abrasion as there is by the cascading of the materials in a rotary kiln.—*Charles Davis, England, U. S. Patent No.* 1,819,739.



Burns clinker while falling



Cools material between grinding sections

Wall Board. Wall board made of cement and asbestos alone can only be colored a few dull colors, and the coloring through the whole board is quite expensive. The inventor claims to have discovered that cellulose-ester lacquers, such as cellulose-nitrate lacquers, either by themselves or with resins, oils, etc., produce a hard surface on such wall board that is weatherproof and resistant to hot and cold water and soap and the usual acid and alkaline cleansers. Slate may be mixed with the asbestos and colored materials may be added to give it the appearance of marble.—*Friedrich A. Brossard, Germany, Assignor to Theodore Hemeke, U. S. Patent No.* 1,820,933.

Wall Board. The feature of the wall board covered by this patent is the method of reinforcing the edge. The reinforcing is made of fabric which is doubled to make a T like section and then forced into the edge of the board. The fabric is carried flat on a roll and three or four sets of bending rolls cause it to take the T-shape just before it is placed in the edge of the board. *Gustave A. New, assignor to American Gypsum Co., U. S. Patent No.* 1,808,003.

Plaster Board. The form of plaster board covered by this patent has been devised to make the plastering stronger at the joints and to prevent the plaster from falling off. This is accomplished by making the edges of the board so that they form ribs in some cases and in others they form dovetailed grooves. The patent covers the construction of a plastered wall with plaster board of this type.—*Thomas D. Priddy, assignor to the Formed Steel Products Co., Cleveland, Ohio, U. S. Patent No.* 1,823,914.

Plaster Board. The back of this board, which goes next to the studding, is a felted sheet which the inventor says may be made of shredded straw, corn husks, excelsior shavings or similar material. This is covered with a layer of waterproof paper. On this metal lath is fastened to the felted sheet by wires. The expanded metal preferably projects on two sides of the sheet of board as shown in the illustration. The plaster is put on the lath and the flexible nature of the felted sheet causes the lath to be self-furring. *Milton S. Wunderlich, assignor to Flaxlinum Insulating Co., St. Paul, Minn. U. S. Patent No.* 1,808,976.

Plaster Mixture. This patent covers the use of cotton fiber, such as cotton linters, to use with gypsum to make a block, slab or board. The inventor claims that in many cases the cost of cotton fiber will be less than the usual wood shavings and wood fiber, because, while the cost per pound is higher, much less of it will have to be used to get the same toughness and nailability. But his claims cover the use of cotton fiber in all amounts varying from 1% to 25% of the combined weight of the gypsum and fiber.—*George H. A. Ruby, U. S. Patent No.* 1,799,324.

Threaten Illinois Highway Funds

Legislature, in Relief Session, Considers Diverting Gas Tax—Would Make More Thousands Jobless—Watch Your State Legislature!

GOVERNOR EMMERSON of Illinois convened the legislature of the state in special session September 6 for the purpose of finding money for unemployment relief. Funds previously raised for this purpose have been spent and further federal loans are denied by the Federal Reconstruction Finance Corporation until the state has shown "that it has exhausted all its own resources for the needy." Apparently it is up to the legislators to either raise money or establish beyond controversy that the state is unable to do so.

It has been pointed out in interviews that about the only practical means of raising the amounts which the relief agencies of the state are asking for is by obtaining as much as possible from state sources, then turning to the federal government. Study is being given to the suggestion that the legislature quickly pass bills providing $15,000,000.

Some of the most frequently mentioned proposals for the legislative relief action are:

1. Increase the gasoline tax from 3 cents to five cents per gallon.
2. Divert the state's portion of the present 3-cent gasoline tax.
3. Authorize the counties to spend any part of their portion (1 cent) of the present gasoline tax for relief.
4. State tobacco tax.
5. State general sales tax.

The road-building and motor industries, as well as individual and organized groups of motorists, truck and bus owners, are alarmed at the prominence given the proposals to again raid the gasoline tax and amazed at this latest effort on the part of those who would unfairly load this additional burden on the shoulders of road users and road builders. To increase the tax by 2c. per gal. would bring the total tax, state and federal, to 6c. per gal., as against a total tax of 3c. per gal. at the start of the year. An increase of 100% in the face of reduced incomes and widespread unemployment would not only be unfair and out of line but it would bar to many thousands the use of the roads they have already paid for and would work great hardships on those who must drive to their daily occupations.

Gasoline Tax Is Road Toll

Since the gasoline tax is nothing more nor less than road toll, proceeds of this tax can be used properly for roads only. Millions of Illinois gasoline tax funds already have been improperly taken for other purposes, with the result that, although paid for by the motorists, needed roads are not being built and many thousands of men usually employed on state road work have been thrown out of employment. It is conceded by many of those most familiar with the gasoline tax law that diversion of the money for other than road-building purposes is illegal and could not stand up under a test in the courts. Quite obviously, it would be pure folly for the Illinois legislature to pin its hopes for relief on a source already worked to the point of diminishing returns and which is said to be almost sure of being subjected to a disastrous fight on its legality.

The state tobacco tax idea has considerable merit. Tobacco, being a luxury rather than a necessity, as in the case of gasoline, is made to pay a penalty tax, such as is common to many luxuries, rather than a toll like the gasoline levy, intended to meet expenses of road building and upkeep, at the same time keeping the charge at a minimum in order to encourage rather than discourage road use. State tobacco taxes in Georgia, Iowa and other states have been surprisingly successful.

Perhaps the fairest and most practical tax for any such purpose as relief of the needy is the general sales levy. An article in Rock Products, July 30, briefly described the Mississippi sales tax and reported the phenomenal success of the measure, even during the first three months. With the tax on certain items not ye in effect, the income was more than 20% greater than carefully prepared estimates. Another month's experience has just been reported, indicating a continuation of these good results. Rock Products, August 27, briefly reported the general sales tax recently passed by the Pennsylvania legislature to provide funds for unemployment relief. It is a tax of this kind that Illinois needs, not further dabbling with legislation adopted for the financing of the state highway system.

Vehicle Users Against Diversion

A real reason against diversion is that the motor vehicle users of Illinois do not want it. The gasoline tax was created as a road toll so that the road user may pay for maintenance and new construction of roads in proportion to his highway use.

Illinois road users have taken a tremendous burden away from property by assuming all the cost of state highway building and a large share of the cost of local road building. Motorists have supported the gas tax wholeheartedly, for among other things it brought the state good roads at a more rapid rate than otherwise would have been possible. To impose a general government cost on motor vehicle users is distinctly unfair in point of ethics and in view of all the motorists have done for the state at great expense.

Road users can afford to pay the present tax rates only so long as the money is spent for road improvement. They have been willing to bend over a little, by permitting high tax rates, because of the vastly improved motor facilities held out for them in the future.

There is every likelihood that diversion of current road money would bring a further reduction in road income by reducing motoring. It must not be forgotten that already some $11,000,000 has been removed this year from state road funds for the purchase of tax anticipation warrants, adding several thousands to the line of unemployed, and if this money does come back to highways it will not be in the near future. In addition, Illinois will this fall vote on a $20,000,000 bond issue, to be financed by gas tax income, for unemployment relief. This money has already been spent.

Frank T. Sheets, chief engineer of the highway department, recently reported that a deficit of more than $700,000 will face the department by December 31. This all means that even now diversion has wreaked considerable havoc in the state highway program. It follows, therefore, that less road progress is being made. As road funds decline, important road projects must be abandoned. So in rural areas and in cities sorely needed improvements must be postponed. Bad roads and congestion do not breed motoring; rather, they retard road usage, and that lessens road income.

So, if less money is available for roads because of diversion and lessened road usage, sorely needed motor facilities would remain unbuilt. Although Illinois is the envy of all states in so far as state highways are concerned, the state is still confronted with two tremendous tasks which, in all fairness to the motorists who have paid for the state roads, must be completed. Illinois can now proceed rapidly on these tasks if unhampered by diversion of motor funds.

Highway Transport Employs Most Men

The nation's greatest employer of men is the highway transportation industry, composed of the manufacture and servicing of motor vehicles, the production and retailing of oil products, and the building of roads. Together they are responsible for one out of every six jobs. Unhampered by unfair and high taxes and given the benefit of road funds applied to roads only, the highway transportation industry can be a leading factor in the return of normal business. Diver-

sion of existing road funds to purposes unrelated to roads, or increasing taxes on motorists and using the extra income for other activities, is one sure way to keep men out of jobs, a sure way to make the business let-down last longer.

Said C. W. Coons, of Peoria, manager of the Illinois Automotive Trade Association, recently: "When we observe 40 or 50 men working around a paving mixer, not by any means do we see the complete army of workmen responsible for that road. One-sixth of the money that goes into a concrete pavement, as shown by government figures, goes directly to men on the project. But every piece of material and equipment on that project has been produced by labor. The building of the road starts in the mines and quarries where iron, coal and other minerals must be dug up. Materials and equipment are made of elements worthless until fabricated and transported by labor. So when all the labor items are totaled up it is not surprising that some 90% of the money spent for roads goes to labor.

"Road building is the only industry which is not overproduced. When a road is built we do not have to sell it to anyone. It is there, ready to serve the public; to make highway travel less costly and safer; to stimulate automobile usage and sales to the further benefit of labor."

Let Road Funds Alone

Rock Products urges every reader to recommend to the state legislature of Illinois that diversion of state highway funds cease and that the gasoline tax be retained inviolate for the purposes of highway building and maintenance. Every dollar raised through the gasoline tax is not only needed for roads, but when so spent provides employment to the extent of 90c. spent for labor. More than $100,000,000 worth of paving is now needed to put in proper condition worn-out or unimproved portions of present state routes within city and town limits alone. Important state routes are uncompleted and many additional miles require widening in order to accommodate with reasonable convenience and safety the present volume of automobile and truck traffic.

Of the several suggestions for providing the funds desired, unquestionably the most practical, as well as the only one which is absolutely fair, is that pertaining to a general sales tax. Illinois legislators should handle the situation fearlessly, with prompt decision and in a manner that will avoid the possibilities of adverse court decision. Attempts to raise funds through diversion of gasoline tax proceeds might, in the opinion of competent legal talent, precipitate a court battle which would withhold the funds in question from use for either road building or unemployment relief.

Mississippi found itself in a situation comparable to that of Illinois. More funds were needed. Mississippi did just what Illinois is doing now, considered the motorist as a possible source. But here the state's courageous governor, M. S. Connor, and his legislative leaders realized that all of the people of the state should come to the front—not motorists alone. So now Mississippi has a 2% general sales tax in operation which is bringing more money than was anticipated. As a result, state property taxes are to be reduced this fall, and perhaps eventually the sales tax will entirely eliminate the property tax.

Pennsylvania considered lifting $12,000,000 out of road funds for unemployment relief. Immediately road users from all over the state righteously protested—civic clubs, motor clubs, chambers of commerce, and so on. The Pennsylvania legislature turned to the general sales tax, and as a consequence all Pennsylvanians will share in the cost of relief; road money will continue to place men at work; road workers will not be added to the relief lines.

In the recently passed Pennsylvania sales tax law, which became effective September 1, practically all commodity is covered with the exception of real estate and farm produce purchased directly from the farmer-producers. We believe that these two exemptions might well be made in an Illinois sales tax law. The Pennsylvania law is to remain in force six months, at the end of which period it may be abandoned, continued as it is, or changed in the light of experience.

Use of Foreign Materials in Relief Construction

THE FOLLOWING STATEMENT has been made by United States Secretary of Agriculture Hyde:

"Protests have come to my attention regarding the use by road contractors of cement and other material manufactured in other countries on roads supported by Federal funds.

"Road construction is under the jurisdiction of the states and territories.

"The Federal government lacks authority to point out that the intent of Congress in passing emergency appropriations for the construction of public roads was to afford employment. That intent was not limited to those engaged directly in road building, but included as well those who would be engaged in the production of material. In my opinion, there is a strong, moral implication, arising from the emergency character of such appropriations, that preference in the materials used should be given to materials produced in this country."

To Build Cement Plant in Iraq

THE Ministry for Traffic and Industry of the Iraq government has granted permission to Dr. Mohammad Haidar to build a cement factory on the condition that the necessary raw material will be purchased only in the vicinity of Kifrin. To obtain capital of £800,000 a syndicate is to be formed. —*Wall Street Journal* (New York).

Contractors Push Relief Construction Projects

INTENSIFICATION of the drive of the construction industry to have the country take full advantage of the provisions of the recently enacted Emergency Relief and Construction Act, thereby assuring the relief intended, will be one of the major objectives of the fall meetings of the executive cabinet, governing and advisory boards of the Associated General Contractors of America, October 9 to 11, at Washington, Managing Director Harding announces.

The executive cabinet of the association will meet on October 9, while the governing and advisory boards will meet on the two succeeding days. These meetings will precede those of the policy committee of the Construction League of the United States, on October 12, and the general assembly of the National Conference on Construction, October 13 and 14.

The general contractors' association has been a steadfast advocate of a national construction program as the only means available at this time to create employment, develop purchasing power and revive industry. In cooperation with the Construction League of the United States, which is composed of the outstanding national trade and professional associations of the industry, the local branches and chapters of the Associated General Contractors have been particularly active since passage of the Relief Act in sponsoring through the National Committee on Trade Recovery the immediate undertaking of all worthy self-liquidating construction projects contemplated in the act. The closer coordination and intensification of this activity will be discussed.

Hanford MacNider Resigns as Minister to Canada

ANNOUNCEMENT has been made of the resignation of Hanford MacNider, president of the Northwestern States Portland Cement Co., as American Minister to Canada, which has been accepted by President Hoover. It is expected that Mr. MacNider will take an active part in the campaign of President Hoover for reelection.

In accepting his resignation President Hoover said, in part:

"In accepting your resignation I need mention but one great service which you have performed during your term of office in Ottawa—the building up of mutual understanding between our government and the great government to the north.

"By the cooperative spirit which you have been able to invoke with officials of both governments you have contributed in large part to the consummation of the great treaty for the development of the Great Lakes-St. Lawrence waterway. It is a notable service, and one of which you may always be proud."

Mr. MacNider was appointed to Ottawa two years ago.

More Wall Street Comment on Cement Price Increases

IMPORTANT PRODUCERS of portland cement are not sanguine that the recent increase in price will have any material effect on their earnings this year, says the *Wall Street Journal* (New York City). It is their opinion, however, that the advance makes it possible for the lower cost producers to look forward to fair earnings in 1933 with a continuance of the current rate of business.

Indications are that demand is firming up and that 1932 will mark the low point of consumption. Contracts are being let by the various states with greater frequency under the Federal Aid Act, while further stimulus to construction is probable as a result of the activities of the Reconstruction Finance Corp.

Federal approval is being requested by Oklahoma for a program involving 109 miles of concrete road 20 ft. wide, with bridges and culverts, entailing use of 650,000 bbl. of cement. Eight contracts on 66 miles of road, requiring 241,500 bbl. of cement, have been awarded by Georgia, while Navarro county, Texas, has let one of the largest awards for single track concrete yet made in that state, calling for 15½ miles of 9-ft. pavement. New York's concrete road program, including bids to be taken up to the middle of the current month, totals 190 miles.

In meeting conditions of the last several years the larger producers have made great progress in reducing operating expenses and improving efficiency. The result is that they are in a position to profit substantially by any stepping up in consumption One important manufacturer states that some of the operating economies effected seemed almost impossible a few years ago, citing as an instance that his company is now producing a barrel of cement with 25% less fuel than two years ago.

The price advance of early August, the first since 1929, of from 19 c. to 29 c. a barrel in the eastern territory (exclusive of metropolitan New York), and 30 c. a barrel in the middle west found dealers with the greater part of their 1932 requirements already booked with the manufacturers for future delivery at the lower price. Also, many took advantage of the interval between the time the price advance was decided on and the date it went into effect—a matter of some five days—to build up their stocks.

No Immediate Further Advance Seen

While the cement industry does not look for any further immediate advance in prices, it believes present quotations are showing increasing signs of greater stability and that the chaotic conditions that existed up to the middle of this year have been remedied. As a result of two years of declining demand and keen competition, marked by price slashing and the granting of secret concessions, the most severe price war in recent years developed during the closing months of 1930. In the first five months of 1931 five price cuts were made, bringing quotations to the lowest point in some 15 years In New York City cement, packed in paper containers and less all discounts, declined 40 c. a barrel to $1.54 a barrel, while the Chicago quotation dropped by 46 c. to $1.40 a barrel and the Albany price by 50 c. to $1.58.

It is unlikely that any consideration will be given at this time to the matter of bringing the metropolitan New York price in line with the rest of the eastern territory. In this district competition is still most severe, due primarily to foreign imports. Europe, with its cheap labor, depreciated currencies, and extremely low ocean freight rates (the product often is carried as ballast), is able to lay down cement in this port at a price that precludes any profit to the domestic competitor.

While small in the aggregate as compared with total American consumption, foreign imports have a demoralizing effect on the coast and immediate adjacent markets. Due to the obstacle of railroad freight rates, this foreign product is restricted to cartage distance of the port of landing with the result that it displaces the domestic output, which is consequently backed up on other markets already well served.

Imports Fall Slighty

During the first six months of 1932 imports of foreign cement have aggregated 206,832 bbl. as compared with 292,608 bbl. in the corresponding period a year ago. In the full year 1931 a total of 457,238 bbl. were imported.

Current indications are that the American mills, with an annual capacity of 260,000,000 bbl., during 1932 will make between 70,000,000 and 75,000,000 bbl. as compared with 124,570,000 bbl. last year and the record of 176,298,846 bbl. in 1928, the latter figure representing 72.2% of capacity. Up to the close of July output this year totaled 41,815,000 bbl. in contrast with 74,032,000 bbl. in the corresponding period of last year.

During July the ratio of the country's production to capacity, according to the U. S. Bureau of Mines of the Department of Commerce, amounted to 33.4%, while the ratio for the 12 months ended with July totaled 34.2%. A year ago these respective ratios were 62% and 53.8%. Output in July amounted to 7,659,000 bbl. and shipments 9,215,000 bbl. and stocks at the mills at the end of the month aggregated 22,479,000 bbl. July's output was off 44.9% as compared with July, 1931, while shipments and stocks were lower by 40.7% and 13.3%, respectively.

1932 Operations Unfavorable

All of the major cement producers will undoubtedly report deficits as the result of 1932 operations.

Universal-Atlas Portland Cement Co., a subsidiary of the United States Steel Corp. and the largest potential producer in the industry, does not make public its financial reports, but it is likely its loss will be substantial.

For the 12 months ended June 30, last, Alpha Portland Cement Co. showed a net loss, after depreciation and depletion, of $1,193,449, as compared with a net income of $546,583, equivalent after preferred dividends, to 57 c. a share on the 711,000 no par shares of common stock outstanding in the preceding 12 months. There are outstanding 20,000 shares of 7% preferred shares, par $100.

As of June 30, last, Alpha had current assets, including $4,902,440 of cash and marketable securities, totaling $7,862,452, against which were current liabilities of $335,801.

Lehigh 12 Months Loss $484,000

Lehigh Portland Cement Co., which has an outstanding capitalization of 450,348 shares of common stock, par $50, and 197,594 shares of 7% cumulative preferred, par $100, for the 12 months ending with June, reported a net loss of $484,020. This compared with a net profit of $1,631,440, equivalent to 46 c. a common share, after preferred dividend requirements, in the 12 months ended June 30, 1931. With the declaration of the $1.75 quarterly preferred dividend last June, the company stated future action on these shares depended on an improvement in earnings, the latter being possibly only in the 6,000,000 bbl. annually.

Pennsylvania-Dixie Cement Corporation for the 12 months ended June 30, 1932, showed a net loss of $1,643,140 after depreciation and depletion. In the preceding year the loss was $115,551. As of June 30, Pennsylvania-Dixie's current assets, including $2,756,989 cash and short-term securities, aggregated $5,446,660 and its current liabilities $409,555. The company has outstanding 130,988 shares of 7% preferred stock, par $100, on which dividends have not been paid since September 15, 1929, and 400,000 shares of no-par common stock.

For the six months ended June 30, last, International Cement Corp. reported a net loss of $759,241 as compared with net income of $1,000,627, or $1.57 a share, on the outstanding 636,124 shares of capital stock in the initial half of 1931. The company also has outstanding $17,995,500 of 5% debentures.

At the current rate of business, it is likely the company's loss for the entire year will approximate $2,000,000 after charge-offs for depreciation and depletion of in excess of $3,000,000, the latter figure being estimated on the basis of such deductions in previous years. During the height of prosperity of the cement industry, International's directors adopted a policy of making liberal charges for depreciation and depletion, which practice is being continued despite the recent decline in business and consequent earnings.

International at 30% Capacity

International during 1932 booked its full proportion of the business available. Currently, its domestic mills, which have an annual capacity of 18,000,000 bbl., are running about 30% of capacity.

A license has just been closed with one of the leading cement producers of Australia for the use of International's Incor process. Last year licenses were granted for the manufacture of Incor for Denmark, Norway, Sweden and Finland. Also, the company's Dallas, Texas, plant was equipped for the manufacture of this line, thus providing facilities for the making of Incor in five states—Pennsylvania, Indiana, Kansas, Texas and Alabama.

Incor, a high early strength cement, was developed by International's chemical engineers previous to 1928, in which year the company was granted patents in the United States and in all the principal foreign countries of the world.

International's foreign business is on a profitable basis, with the exception of Cuba, where general business conditions have been severely affected. The Cuban plant is running between 15% and 20% of capacity, while the South American plants—one each in Argentina and Uruguay—are operating at around 65%. Foreign plant capacity of the company is about 6,000,000 bbl. annually.

$3,000,000 Plant for Brazil

Late in December or early in January, International will enter another South American country. In Brazil one of the most modern plants in the world is being erected at a cost of about $3,000,000 The capacity of this plant will be 800,000 bbl. annually, and provision has been made for the doubling of output in a short time if demand improves. The mill is close to its source of raw material and located conveniently on the Bay of Rio, thereby insuring cheap delivery to its principal market, the city of Rio de Janeiro.

This new plant probably will be a good contributor to the company's revenue next year, as the demand for cement in Brazil is large and growing and in the past has been met mostly by European imports, which pay a high tariff. Recently to meet its cement needs Brazil reduced its cement tariff by 50% for 60 days, a period which will expire as International's new plant is brought into operation. Up to the time International entered the field, but one small mill existed there and that was close to the city of Sao Paulo.

St. Lawrence Waterway and Its Effect on the Cement Industry

IN COMMENTING on the effect of the St. Lawrence waterway, which has been agreed upon subject to the approval of the legislative bodies of Canada and the United States, the *Buffalo* (N. Y.) *Times* comments as follows:

"One immediate effect of the opening of the St. Lawrence waterway would be to subject 15 cement plants within 50 mi. of Lake Erie to the same Belgian price cutting competition faced by plants on the Atlantic seaboard.

"Altogether the 15 cement plants in the Lake Erie region employ more than 3000 persons and have payrolls of more than $1,000,000. They manufacture more than 15,000,000 bbl. of cement each year.

"The financial effect of price-cutting foreign competition goes farther than the workers and cement plants themselves. In every barrel of cement 500 lb. of limestone, 150 lb. of shale, 15 lb. of gypsum and 120 lb. of coal are used in manufacture. All of these ingredients must be transported to the cement plants, thus providing wages to miners and railway workers.

"Any foreign price cutting in the Lake Erie region would inevitably unsettle all the existing commercial machinery now utilized in the manufacture of cement.

"A study of recent hearings before the United States Tariff Commission on the question of a protective tariff for cement shows what the Lake Erie cement manufacturers might expect.

"The Atlantic seaboard manufacturers complained before the tariff commission that Belgian manufacturers with their price cutting tactics had forced a large section of the American cement industry to market its product below cost.

"The record of that tariff hearing shows that Belgium was laying cement down on the Atlantic seaboard at a rate of $1.47 a bbl., while the lowest price the American manufacturers, who did not have available the same cheap labor used by the Belgians, was $1.98, giving the Belgians a spread of 51 c. the bbl."

Opens New Gravel Plant in Missouri

J. A. HUTCHISON, Springfield, Mo., formerly superintendent of the eastern division of the Frisco railway, has opened a commercial sand and gravel plant near Halltown. The plant will have a capacity of 200 tons per day, the *Springfield Press* reports.

The plant was partially constructd about a year ago by the Atlas Sand and Gravel Co., but operations were not started at that time. According to Mr. Hutchison, who has an operating contract for the plant, actual production will start soon.

The plant is located on a 40-acre tract and material will be obtained from a deposit in the Goose river bed. At present sand is taken to the plant by teams, but machinery is to be installed to convey it from the deposit to the plant. Screening, washing and crushing equipment are included in the plant, though only one size of material is being produced. Later, additional equipment is to be installed and production of other sizes is scheduled.

Urges Property Repair and Improvement Work

DECLARING that potential repair, maintenance, and modernization of home, commercial, and industrial structures in every American community could be made worth "$3,500,000,000 to America's unemployed," Frederick M. Feiker, director of the Bureau of Foreign and Domestic Commerce, recently promised the full cooperation of the National Committee on Reconditioning, Remodeling, and Modernizing in a nation-wide campaign to accomplish that purpose.

"It is to accelerate this movement that the National Committee on Reconditioning, Remodeling, and Modernizing is only too anxious to cooperate with every community interested in promoting repairs and improvements of commercial, home, and industrial structures for the purpose of energizing industry and relieving unemployment," he stated.

Mr. Feiker pointed out that in the neighborhood of $5,000,000,000 worth of repairs are needed to keep existing structures in good condition and that of this amount approximately $3,500,000,000 would constitute wages for local labor. It is the purpose of this committee to accelerate the demand for men and materials by stimulating the repair and improvement of existing structures.

William Leon Ellerbeck

DR. WILLIAM LEON ELLERBECK, 57, president and general manager of the Nephi Plaster and Manufacturing Co., Salt Lake City, Utah, died in a local hospital, August 12, of pneumonia following an operation.

He was born in Salt Lake, attended public school and was graduated from the University of Utah, where he specialized in metallurgy and chemistry. He later studied dentistry in the University of Pennsylvania and in 1899 was graduated with high honors.

He practiced in Salt Lake a number of years, after which he returned to Philadelphia to accept the position of special lecturer in dental chemistry and metallurgy at the University of Pennsylvania.

Dr. Ellerbeck was the first editor in chief of the *Pennsylvania Dental Journal* and was a member of the editorial staff of the *International Dental Journal* in 1900 and 1901.

After returning to Salt Lake he took up work with Utah clays and in 1903 organized the Clinton-Ellerbeck Clay Co. In 1904 he reorganized the company, naming it the Utah Fire Clay Co.

Gypsum attracted the interest of Dr. Ellerbeck in 1906 and he built the Nephi Plaster and Manufacturing Co. at Gypsum in 1909. He later built the Nephi Keene's cement mill and did technical work for that company. In 1917 he organized the Utah Lime and Stone Co.—*Salt Lake City* (Utah) *Tribune*.

Cement Products

TRADE MARK REGISTERED WITH U. S. PATENT OFFICE

Modern Batching Plant Helps Merchandise Raw Materials

Lake Erie Mining Co., Peoria, Ill., Installs Latest Automatic Batching Equipment

ONE of the most complete and up-to-date batching plants to be found anywhere in the Central States was recently completed and put into operation by the Lake Erie Mining Co. at Peoria, Ill.

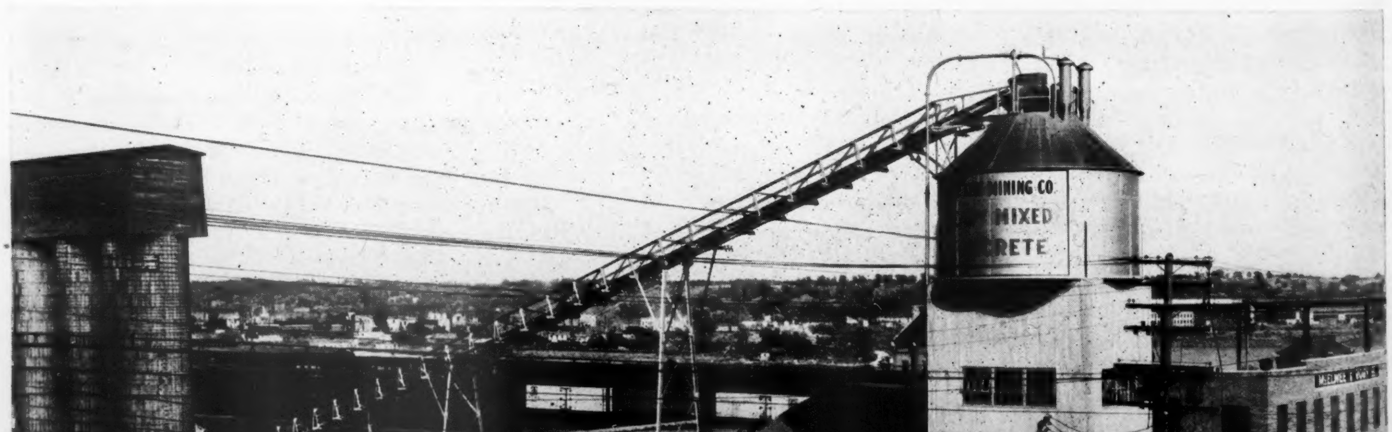
It is entirely automatic in the proportioning of the materials, using push buttons in connection with photo-electric cells and relays for starting and stopping each feeder. An unusual feature is the proportioning of the water by weight. The plant was designed and furnished by the Stephens-Adamson Manufacturing Co., and was erected by the Lake Erie Mining Co.

Batching plant at left, garage in foreground, and storage silos beyond

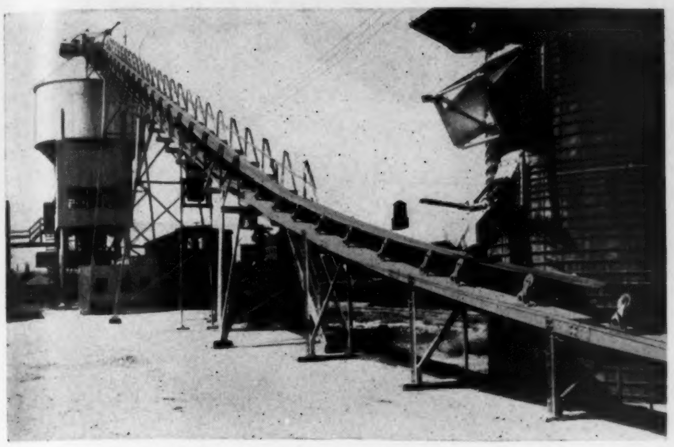
Handling of Raw Materials

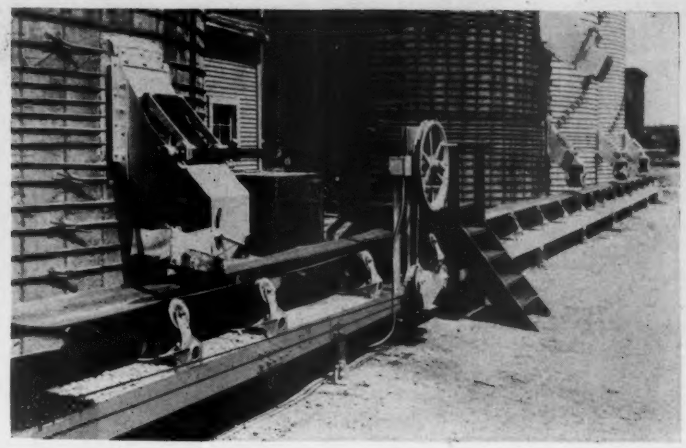
The aggregates are brought in by rail and put into storage silos by means of a track hopper and Godfrey bucket system, each size in a separate silo.

The storage system includes a row of six



General view of plant, batcher and garage at right; storage silos at left





Two views of belt conveyor which carries aggregates from storage silos to batching plant. Note unusual construction of gallery at left and hand wheel and push buttons at right for controlling turnspout and conveyor

16-ft. concrete stave silos with a capacity of about 350 yd. each. From these the materials are taken to the batching plant, one at a time, on an 18-in. by 303-ft. belt conveyor located alongside the silos. This conveyor, which has a capacity of 150 tons per hour, has Stephens-Adamson "Pacific" type carriers with Alemnite-lubricated Timken roller bearings and is driven by a 15-hp. General Electric motor through a Jones herringbone-Maag gear reducer and Jones flexible couplings.

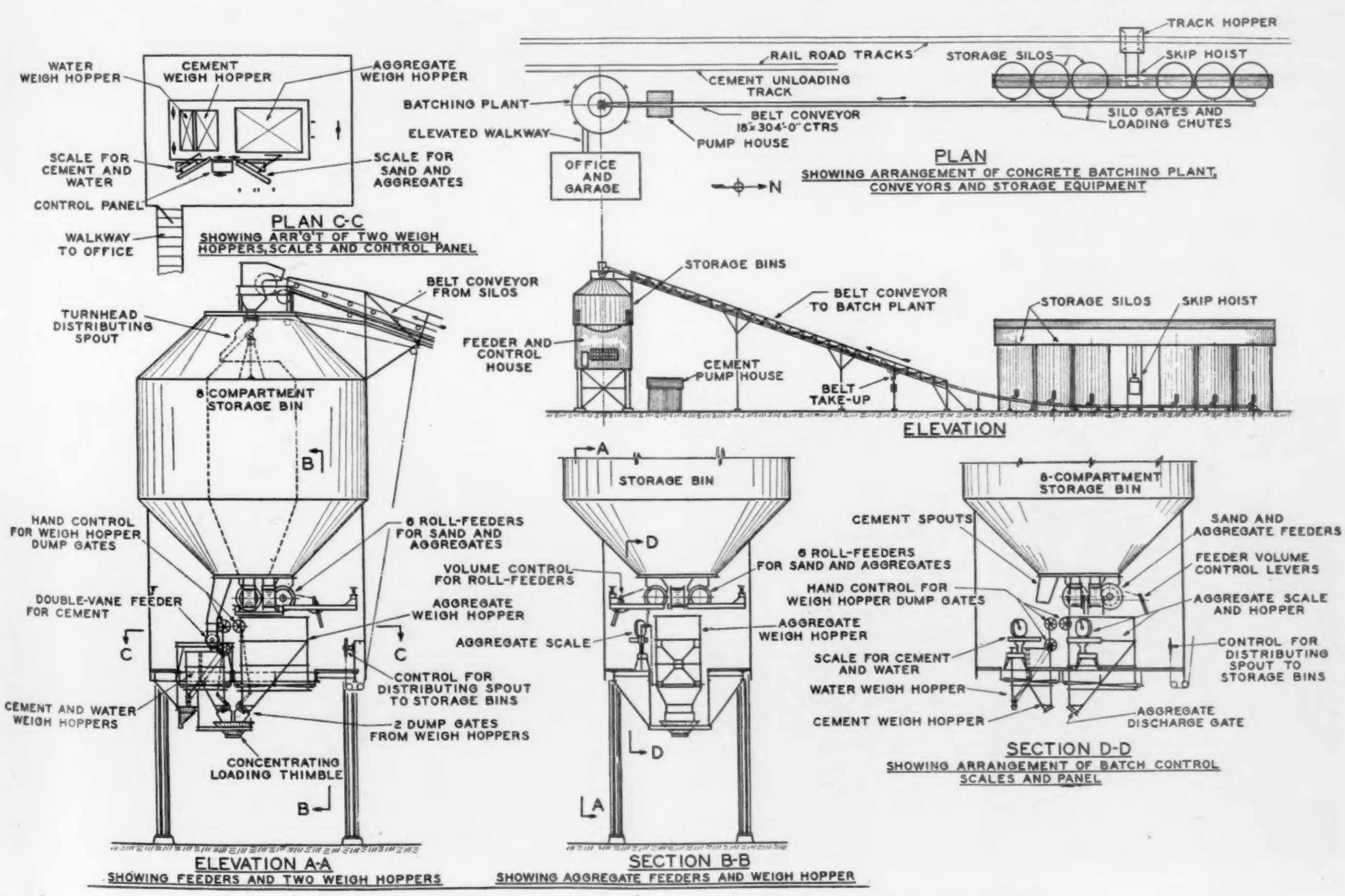
At the head end it is equipped with a silent ratchet and pawl holdback to prevent reversal of the belt, and a turnhead spout is used to direct the discharge from it to any one of the bin compartments.

This turnspout is connected by cables with a hand wheel located alongside the belt conveyor at the midway point of the silos, as shown in one of the illustrations, so that it can be turned to any compartment without the necessity of going to the top of the bins. This hand wheel was originally placed in the operating room, but was later moved to its present position as being more convenient.

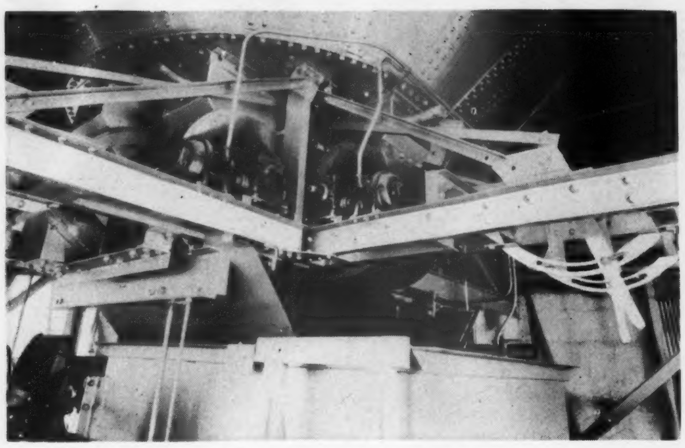
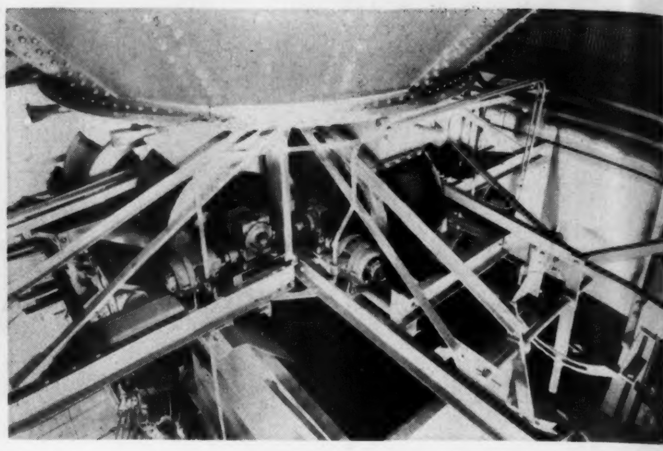
One man takes care of the feeding of the aggregates from the storage silos to the bins, setting the turnspout at the proper compartment by means of the hand wheel, regulating the feed from the silo and starting and stopping the conveyor from a convenient push button station alongside the wheel. When the bin is nearly full the material moves a vane which through an electrical connection sounds a siren and warns the operator to stop the feed. As soon as the belt is clear of material the procedure is repeated for another size. The plant is designed for two-man operation, one handling the aggregates and one operating the batcher.

Batching Plant

The batching bin is a circular steel bin with conical bottom, mounted on steel col-



General arrangement of plant of Lake Erie Mining Co., Peoria, Ill.

Two views of roll feeders below batching bins, showing feeder drives and levers for regulating the discharge opening of each feeder

umns and divided into eight compartments. Below it and supported on the bin columns is the operating room in which are located the feeders and weighing equipment.

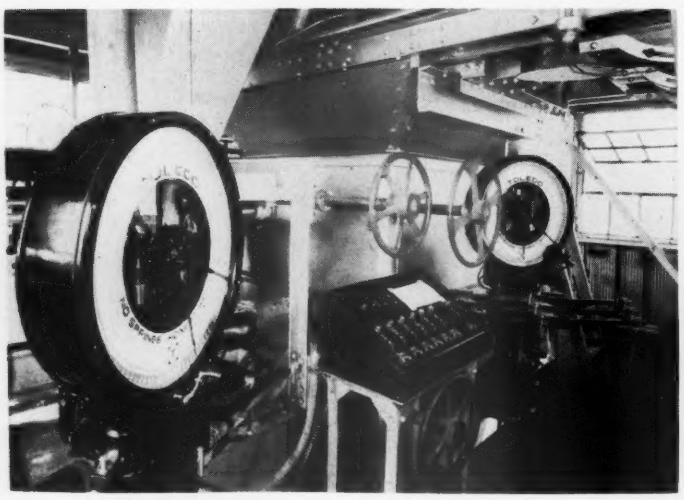
The eight bin compartments comprise two 60-ton bins for cement, four 50-ton bins for aggregates, and two 75-ton bins for aggregates. All discharge slopes have an inclination of at least 45 degrees and all valleys have rounded corners to facilitate the flow of the materials. The six aggregate compartments are for two grades of sand and ½-in., 1-in., 1½-in. and 2-in. gravel. This is one of the few plants arranged to handle so many sizes of aggregates and was designed so that the batches could be proportioned in the latest and most scientific manner for best grading of aggregates, thus reducing voids, increasing concrete strength and saving cement. One cement bin is for state-tested cement for use on state paving jobs, and the other is for standard cement for use on other than state work.

Storage silos with building supply yard in foreground

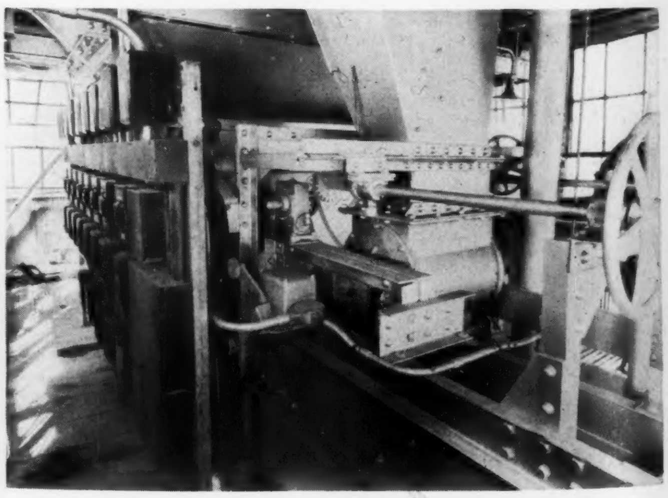
Bulk Cement Is Pumped

Bulk cement is received in railroad cars alongside the batching plant and is put into the bin by means of a Fuller-Kinyon pumping system as indicated in several of the illustrations. The pump is located in a small house alongside the track and is fed by a portable connection running into the car. This unit, driven by a 30-hp. Westinghouse motor, is capable of handling cement up into the bin at the rate of 20 tons per hour.

Below each of the six aggregate bins a roll feeder is used instead of the usual hand-operated gate to feed the material from the bin to the weighing hopper below. These feeders are a new type developed by the Stephens-Adamson Manufacturing Co. Each is driven by a ½-hp. General Electric motor through a Jones speed reducer and is started by push button from a control board. The cement is fed from either bin by a rotary vane feeder which is electrically driven and operated in the same manner as the others. A small Gardner-Quincy compressor supplies compressed air for connections into the bottom of the bin to prevent bridging or hanging up of the cement.



Cement scale at left; control board in center; and aggregate scale with beams beyond



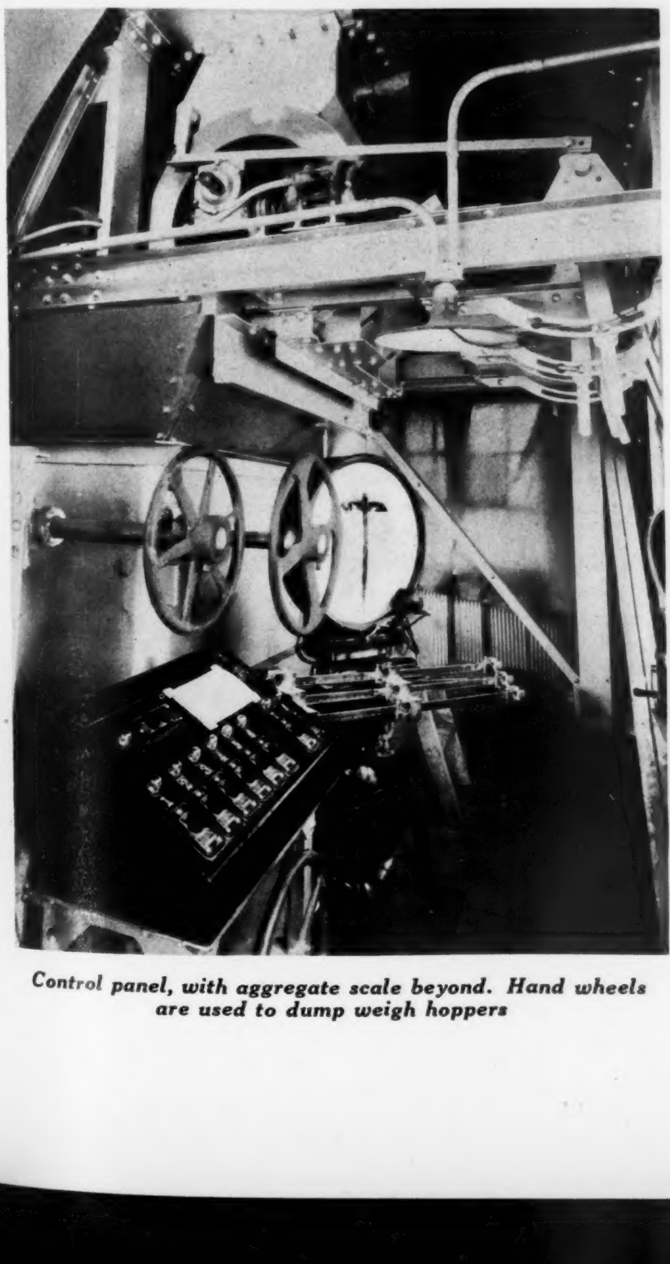
Part of the control relays, at left, and the rotary feeder for drawing cement from the bins

Part of the fleet of agitator-type delivery trucks

The weighing hopper for the aggregates has a conservatively rated capacity of 4½ cu. yd. and is connected with a Toledo dial scale of 25,000-lb. capacity. A separate hopper, connected with a 5000-lb. Toledo dial scale, is used for weighing the cement and water.

Automatic Weighing

The aggregate scale is arranged with six beams and the cement and water scale with two beams, for recording weights. Both scales are equipped with photo-electric cells and relays so that the feeders are automatically stopped when the required weight of material is in the hopper. The water is measured in the same way by means of a push button operated solenoid valve which is automatically closed by the photo cell on the cement and water scale. A print strip recorder on each scale gives a complete record of the daily production, giving weights of aggregates, cement and water for each batch. This print strip recorder has nothing to do with the weighing, being used for accounting purposes.



Control panel, with aggregate scale beyond. Hand wheels are used to dump weigh hoppers

One of the reasons dial scales were chosen for this plant is that the inspector can at any time make make a rapid and accurate visual check of batch ingredients without slowing up producttion.

In proportioning a batch the operator sets the scales to the desired weights and starts the feeders by means of the push buttons. When the weight is reached the feeders are automatically and instantly stopped.

Loading at the batching plant is done through a telescopic spout operated by the driver through a long lever, thus avoiding any spilling at that point. After the concrete is delivered on the job the water in the auxiliary tank is used to thoroughly clean and wash the drum during the return trip.

The material is delivered in agitator type trucks equipped with three 3-yd. and three 2-yd. Rex moto-mixer bodies furnished by the Chain-Belt Co., Milwaukee, Wis.

The Lake Erie Mining Co. is a recent consolidation of two older companies, the former Lake Erie Mining Co. having been engaged in coal mining east of Peoria for more than 20 years. This company was controlled by James McElwee, Sr., who also about six years ago formed the Contractors and Builders Supply Co. This latter company built and operated a gravel plant at Chillicothe, 15 miles north of Peoria. Mr. McElwee is president and W. C. Gill is general manager of the new company. B. C. Locke, chief engineer of the Lake Erie Mining Co., supervised the design and erection of the batching plant.

Tests Friction of Road Surfaces

AN ANSWER to the question of what makes one kind of road more slippery than another is being sought by engineers at Ohio State University. Friction tests are being made between automobile tires and road surfaces under practical conditions.

Tests have been made so far on various types of asphalt block, bituminous concrete, portland cement concrete, brick and penetration macadam roads. The friction was found to vary greatly, especially when the roads were wet.

From the results so far, Professor Stinson stated, "wet surfaces usually have a lower coefficient of friction than dry surfaces. This, however, is not true of all types of roads. Especially on wet roads the coefficient of friction is much less when the speed is increased."—*Columbus* (Ohio) *Citizen.*

Plan New Crushing Plant

CRUSHED rock for the paving of highway 10-78 will be obtained from the quarries at Lexington, Ga., the *Lexington Echo* states. It was stated that waste rock from the formerly operated quarry had been offered at a low figure.

Tests of Concrete from Central Mixing Plant

A PAPER, "Tests of Concrete Conveyed from a Central Mixing Plant," describing tests by the late Willis A. Slater, has been reprinted from the Proceedings of the American Society for Testing Materials as Circular 74 by Lehigh University.

Belt Conveyor Theory and Practice

Part III—Belt Conveyor Drives

By G. F. Dodge, M.E.

TWO VARIABLES, coefficient of friction and arc of contact of the belt with the driving pulley, influence the effectiveness of transmission of power from the drive and hence the slack side pull.

Almost from the beginning a coefficient of friction of 0.25 for bare pulleys and 0.35 for lagged pulleys has been accepted as standard practice, and needs no alteration except for conditions where the belt may be wet, or icy in cold weather. To avoid overstressing the belt by additional slack side (take up) tension, the drive under such conditions should be lagged but figured as bare in arriving at the total belt stress.

The effect of arc of contact is found by the usual formula for transmission belts. The ratio of drive pull to horsepower pull, "drive coefficient" figured from this formula with the two coefficients of friction of 0.25 and 0.35 is given in table No. 7 for the various arcs of contact usually encountered.

TABLE VII—DRIVE COEFFICIENTS

Arc of contact of belt, degrees	Bare pulleys	Lagged pulleys
180	1.85	1.50
200	1.72	1.42
220	1.62	1.35
240	1.54	1.30
260	1.47	1.26
360	1.26	1.13
380	1.23	1.11
400	1.21	1.09
420	1.19	1.08

Drive pull (total pull due to power) is found by multiplying the horsepower pull by the appropriate drive coefficient. Slack side or take up tension is drive pull minus horsepower pull. Two types of drive that will be described later have theoretical drive coefficients of unity, that is, no slack side pull is required and therefore the total pull due to power is equal to the horsepower pull. It should be borne in mind that total pull due to power may still have to have items 11 and 12, Part II, added before the maximum pull on the belt is found, depending on the type and location of the drive for inclined conveyors. This will be developed in the later discussion.

Simple Level Conveyor

This is the simplest of all conditions and the maximum tension will be:

Hp. pull $\times$ drive coefficient

which will be at the drive pulley. The tension at the tail (take up) will be the slack side tension plus the frictional pull induced by the return belt. With long conveyors it may become necessary to introduce something other than the single end pulley drive but the maximum tension will still be horsepower pull $\times$ drive coefficient and the take up tension will be the slack side tension plus the friction of the return belt between the drive and the take up. Theoretically, a simple level conveyor should run equally well in either direction without increasing the belt stress although the load on snub and take up pulleys would of course increase. Practically, however, a plain drive should not be used at the tail (unavoidable with reversible conveyors), except on short conveyors. Starting under load is frequently unavoidable. The inertia forces of load and moving parts cause extra stresses, extra stretch, and a progressive starting along the belt with the result that extra slack will accumulate at the point where it leaves the drive pulley and adhesion be lost unless the belt is continually run under a tension sufficient to overcome this condition. All tail driven conveyors of this type should have lagged drive pulleys regardless of the figured belt stress. With single end pulley drives the arc of contact will depend upon the diameter and location of the drive pulley, the diameter of the snub pulley and the distance between the top and bottom belts. The latter will generally run between 14 in. and 16 in. The minimum size of pulleys should not be less than the following for any conveyor:

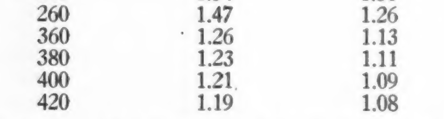


Fig. 1. Simple level conveyor

Drive pulley........5 in. of diam. per ply of belt
Tail pulley..........4 in. of diam. per ply of belt
Snub pulley........2½ in. of diam. per ply of belt

Head pulleys in the case of internal and tail drives should preferably be the same diameter as the drives, never more than one nominal size smaller, and snubs if ahead of the drive should be increased at least one nominal size.

These ratios of pulley diameters to belt thickness have been proven from long experience to insure against destruction of the belt by bending and therefore the use of larger sizes is wasted expense except where a reasonable increase in the drive pulley diameter gives a sufficiently increased arc of contact to permit a thinner belt or the retaining of a simple drive instead of one of the more expensive types. Large drive pulleys, in addition to costing more, cause increases in shafts, bearings and reduction gearing.

Simple Inclined Conveyor

Fig. 2 is similar to Fig. 1 and most of the comments for Fig. 1 apply. This arrangement is more likely to develop into maximum thickness of belt, however, and very frequently will require a "hold back" to prevent reversal if power is lost when loaded. This will be the case whenever the horsepower of lift exceeds the horsepower of friction. Ratchet, roller and band brake types of mechanical hold backs are widely used but the most satisfactory type is a magnetic brake on the motor shaft. The torque value of the magnetic brake (50%, 75% or 100% of motor torque) will depend upon the horsepower of lift. Theoretically, the difference between lift and friction should be sufficient but it must be borne in mind that vibration of the supports may break the idler friction and gradually bring all component of the load into effect so that any type of hold back should be designed for the torque due to lift horsepower. Harsh-acting types such as the ratchet, should have ample allowance for impact.

In Fig. 2 an alternate, automatic type of takeup is shown, more expensive than screw take ups, but desirable if the belt stress is high, as excess takeup tension will not be needed for starting under load. With such an arrangement the weight may be fixed either by the slack side tension or (with antifriction idlers) by the pull necessary for holding up the lower strand of belt and producing enough tension at the tail to prevent sagging between idlers at the loading point. Although not quite so quick in picking up slack in starting, an intermediately expensive arrangement is obtained by leaving the take-up at the tail end and making it automatic. Pull back weights will be needed if the inclination is not sufficient for the component of the weight of pulley, shaft, bearings and sliding frame to produce the necessary belt tension.

Fig. 2. Simple inclined conveyor

Under certain conditions conveyors of this type may be run in the opposite direction and this will be discussed under lowering conveyors.

Internal Drive

Disregarding the extra cost, some operators insist on having all drives located at the ground elevation, requiring an internal drive. The take up should then be in the

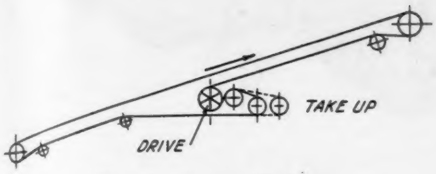


Fig. 3. Internal drive

position shown in Fig. 3, as otherwise it is difficult to maintain slack side tension. If full arc of contact is to be maintained the auxiliary snub pulley next to the drive is necessary. In the author's opinion an arrangement like this is rarely justified. It adds the expense of several extra pulley outfits and increases the power and the belt stress, due to turning these pulleys, two of which are under heavy belt stress. A further belt stress is added due to the fact that most of the effect of the return belt is lost for producing slack side tension, requiring added take up tension.

As a general rule the drive should be at the upper end of an inclined conveyor if the belt stress is to be kept to a minimum. On a level conveyor the location of the drive (head or internal) will have no effect on the belt stress except the load of turning the extra pulleys, if internal.

Internal tandem drive

When belt stress computations indicate that a smaller drive coefficient (Table VII) is needed to keep the belt within practical

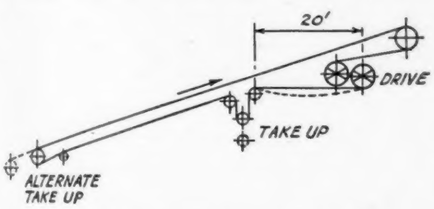


Fig. 4. Internal tandem drive

limits (Table I, Part I) recourse to a tandem drive (Fig. 4) may be had, as it is possible to realize an arc of contact of 420 degrees or more by proper arrangement of the two driving pulleys that are geared together. Here as in the immediately preceding discussion a minimum belt stress is attained by keeping the drive at the highest point possible. A tandem drive is almost always an internal drive although it is sometimes possible to use the head pulley as one of the drivers as indicated in Fig. 5.

Head Tandem Drive

When this is done the take up should be arranged as shown, otherwise the snub friction will tend to hold the belt back causing

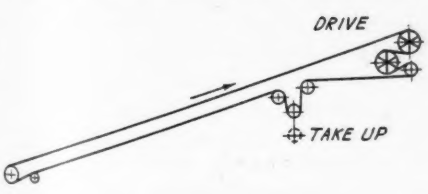


Fig. 5. Head tandem drive

loss of slack side tension. Such an arrangement reduces the number of pulleys under heavy belt tension, saving a little in power and cost of machinery as compared to Fig. 4, but most generally runs into layout complications. The number of pulleys of Fig. 4 can be reduced by two by putting the automatic take up at the tail as described for Fig. 2. The snub back of the drive, however, should be located at least 20 ft. away as indicated, with a generous clearance (4 ft. or more if possible) allowed for belt sag between. This acts as an automatic take up at the drive and compensates for the lag in taking the return belt away at this point when starting.

Tandem drives have been a subject of controversy among conveyor engineers ever since their introduction some 25 years ago, and while a theoretical point can be made against them, practice these many years refutes most of the theory. The theoretical point is indicated in Fig. 6 which shows a tandem drive with the belt thickness greatly exaggerated.

Theory of Tandem Drive

Due to practical reasons which dictate equal size pulleys, the radius to the center of the duck on pulley *A* is greater than on pulley *B*, because of the difference in thickness of top and bottom covers. In ordinary practice this amounts to from 3/32 to 5/32 in. with new belts being gradually reduced as the top cover wears away. This would indicate that pulley *B* should rotate slightly faster than *A* if slipping on *A* is to be avoided. Theory and tests both show that less than 30% of the work is done by pulley *B*. Allowing for slack side tension, the stress in the belt going on to *A* is over three times what it is going on to *B*. Due to the shortening as the stress is reduced, pulley *B* actually has a shorter length of belt to move than *A*, thereby compensating in a large measure for the difference in radius. That

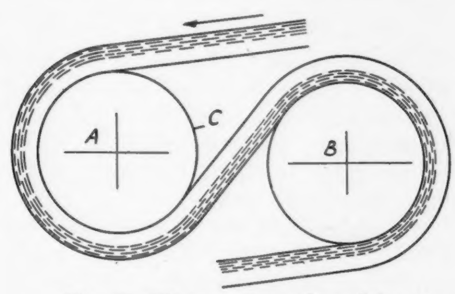


Fig. 6. Theory of tandem drive

this must be true seems to be borne out by the fact that no great difference in wear of lagging on the two pulleys is noticeable and this is where the effect of slippage could be most easily observed.

A differential gear drive (Hegler and Holmes) was patented in 1916 to compensate for this difference in radius and also arranged to divide the power between the two pulleys in about the proper ratio. A few installations have been made and seem to give the desired results but the benefits were not sufficient to warrant its wide application in view of the added cost and complication. Another patent (Reid, 1924) has had a wider use. In this design each pulley is driven separately by its own motor and gear reduction, the electrical slip in the two motors adjusting their speeds automatically as required. As mentioned before, the division of work between the two pulleys is approximately 72% and 28%, depending on relative arcs of contact, and the power should therefore be applied in about that ratio if belt tension is to be kept to the minimum. Nevertheless, of quite a number of two motor drives in use the author knows of but one where motors of different ratings were used. In fact, on an inclined belt no benefit results *if* the drive is so located as to give a sufficient length of belt behind the drive, as the component of this belt (with antifriction idlers) will give sufficient slack side tension for equal motors and thus the benefits of duplication can be retained.

Inverted Tandem Drive

Some engineers believe in a different system of wrapping the belt on the two pulleys from that shown in Figs. 4 and 6, advocating an inverted arrangement as shown in Fig. 7 to get the clean side of the belt in

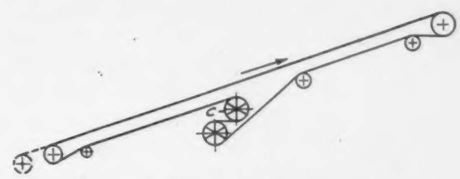


Fig. 7. Inverted tandem drive

contact with the pulley doing the most work. Reference to the discussion of Fig. 6 will show that this wrap would increase the tendency to slip, but two practical items are of more importance. An additional pulley is added under a highly stressed portion of the belt and a scraper that can be applied to the dirty pulley of Fig. 6 to prevent building up cannot be applied to Fig. 7 as the material scraped off cannot get away.

Hugger Drive

Fig. 8 shows a patented drive (Piez, 1919) that has a drive coefficient of unity. That is, no slack side tension is needed and therefore a thinner belt may be used. In this drive adhesion is produced by pressure from an endless belt riding on the outside of the carrying belt where it passes around the driving pulley. It is inherently an internal drive and therefore requires a number of extra pulleys which add to the cost. It re-

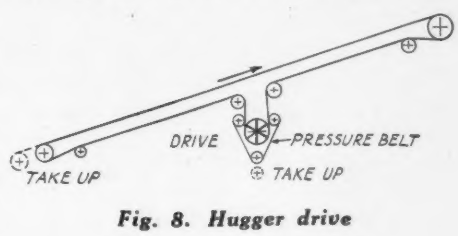


Fig. 8. Hugger drive

quires considerable space under the conveyor for its installation and increases slightly the power requirements because of the extra pulley outfits that have to be driven.

Unity Factor Drive

Another patented drive (Dodge, 1930) shown in Fig. 9 also has a drive coefficient of unity. A pulley carried by a swinging arm is pressed against the belt by springs with sufficient force to cause added friction at the line of contact equal to what the slack side tension would have to be with an equivalent arc of contact on a plain single drive. To distribute the pressure over a reasonable area the pressure pulley has an outer surface made up of high grade rubber rings with hard duck and rubber base. Due to the concentration of pressure both pulleys must be made with rims of a design to resist the bending between the arms. Also because of the concentrated shearing force the lagging must be more securely attached than in ordinary practice and it is more necessary that the lagging be thoroughly stretched in place when being applied.

An advantage of a drive of this type over Fig. 8 is that it may be applied either as an internal or as a head drive. In fact the head is the most favorable location because of the reduction in number of pulleys and cost. Wherever it is located the force exerted by the pressure pulley largely opposes the pull of the belt and reduces the bending forces in the driving shaft so that the forces in that shaft are largely torsional. In addition to producing the necessary friction the springs have to be strong enough to hold the component of the return belt if the conveyor is inclined.

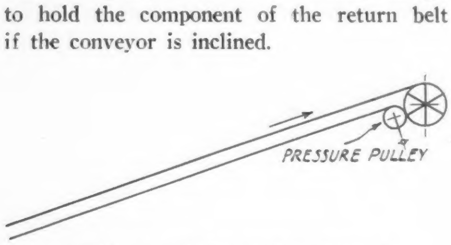


Fig. 9. Unity factor drive

In earlier parts of this article under "power" and throughout the discussion of drives mention has been made of the effect that location of the drive has on belt stress. It has been indicated that although friction is the same, or practically so, for either a head or tail drive for level conveyors, a material increase in take up tension is necessary with a tail drive to prevent slipping when starting under load, while for internal drives there is no difference except for turning extra pulleys under heavy belt loads, provided proper sag is allowed as in Fig. 4 behind the drive.

It is on inclined conveyors that location is most significant and to make an exact analysis it is necessary that the conveyor coefficients of Table VI, Part II, be divided into two parts so that the top and bottom strands of belt may be investigated separately.

TABLE IX—PER CENT OF CONVEYOR COEFFICIENTS DUE TO TOP STRAND

Width of Conveyor	Material weighing 25 to 75 lb. per cu. ft.	Material weighing 75 to 125 lb. per cu. ft.
16-in.	66%	67%
18-in.	66%	67%
20-in.	66%	67%
24-in.	66%	67%
30-in.	66%	67%
36-in.	66%	68%
42-in.	67%	68%
48-in.	67%	70%
54-in.	68%	71%
60-in.	68%	71%

Table IX gives the percentage of each "conveyor coefficient" in Table VI that is due to the top strand. The remainder is due to the bottom. These are to be applied to roller bearing idlers only, as there is rarely sufficient excess effect above friction for the return belt to have much effect with plain bearing idlers. Load coefficients of course apply to the top strand only except in some very special cases where both strands are used, in which special coefficients will have to be figured.

(To be continued)

State Closes Gravel Plant Claimed Unsafe

THE Independence Sand and Gravel plant at Independence, Ore., was closed the middle of August so far as the production of crushed rock is concerned, as the plant was condemned by the state labor commission as being unsafe. The company is permitted to empty its bins, where is stored a considerable quantity of sand and gravel and crushed rock. Ground storage of crushed materials and sand is also available, but as far as production is concerned the plant is closed.

This came at an inopportune time, as the company is in the midst of large contracts for materials for highway construction in this county and also for materials for the Sheridan project.

This plant was established about 20 years ago and was operated for several years under the management of the late Marshall Pengra. For the past few years it has been operated under the management of C. G. Skinner, with the C. K. Spalding Logging Co. a large stockholder.

Just what will be done relative to the construction of a new plant Mr. Skinner is not prepared to state, but tentative plans for the reconstruction of a plant farther upstream toward the point of the island, which is its base of supply, has been in mind for some time.

The company owns a considerable stretch of water front near its present plant and there is an inexhaustible supply of good gravel and sand.

It has been known for some time that the present plant was shaky, but it was hoped by the management that present contracts might be filled before the order came to close down. —*Salem* (Ore.) *Capital-Journal.*

Powder Manufacturer's Experiment Station Centralizes Activities

THE CENTRALIZATION of all divisions of experimentation and research at the new Experiment Station near Wilmington, Del., is announced by Hercules Powder Co. The changes will bring all experiment activities in closer touch with the company's main offices and will enable more complete contact with industries using Hercules products, it is stated by Harry E. Kaiser, director of the Hercules Experiment Station.

The Kenvil, N. J., branch of the experiment station will cease to function as a separate organization and the Kenvil facilities will be taken over by the company's explosives department and placed under the jurisdiction of the adjacent Kenvil plant. R. S. Hancock, assistant director in charge of explosives research, will be transferred to the main laboratories near Wilmington. The executive offices of the station will hereafter be at the Hercules home office.

With the completion of the reorganization, all general research will be centered at Wilmington and all development work of an operating or sales nature will be carried on at the plants making the product involved. The new Hercules Experiment Station, which was completed and put in operation last year, is located on a 300-acre tract of land about five miles west of Wilmington.

Henry Ford Sees Decline in Mass Production

A GRADUAL DIMINUTION of concentrated mass production was glimpsed by Henry Ford in an interview on his 69th birthday.

"I think that the day is coming fast now when we can distribute our industry to small towns, giving them self-support," he said. "I don't mean by that that mass production will stop, for it won't. But improvements in our machinery and inventions are removing the necessity for such concentration of manpower.

"We are experimenting with this, as we are with dozens of other things. At Ypsilanti, for instance, we have just completed a plant which will make all the parts for a certain section of our car. A plant like this working the year round, should be able to support a city of 10,000 or 15,000 persons.

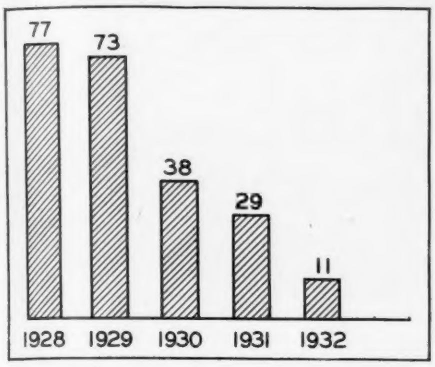
"I think that in time we should be able to make all our bodies near the farm, using the farm produce for raw material. We have not got that far yet, of course, but everyone here about the shop has it in mind and I am confident there will be a solution.

"It's true that the world has got mass production out of suffering of many people. Perhaps we have had some part in our shop to bring about this mass production. It was necessary because it could be produced—things the people really wanted."—*Wall Street Journal* (New York City).

July Accidents

THE RECORD of accidents for the month of July in the member plants of the Portland Cement Association shows that there were a total of 11 lost-time mishaps, with no fatalities, as compared with 15 lost-time and 2 fatal accidents during June and 27 lost-time and 2 fatal accidents during July, 1931.

The most serious personal injury accident of the month occurred to a laborer in a packing department who was placing a bolt



July accidents in cement industry

in a conveyor to hold the gudgeon. He used one of his fingers instead of a drift pin. When the parts moved his finger was so severely injured that amputation was necessary. The loss of time was about three weeks.

This unfortunate accident emphasizes again the oft-repeated warning against placing any part of the body on or near machinery or equipment that is moving or likely to move without warning.

A conveyor tender in the crushing department was climbing the frame supporting the rock feeder. After placing his foot on an iron pipe conduit containing a lighting circuit the pipe broke at a coupling, a wire "shorted" and the victim received sufficient shock through shoe nails to cause him to lose his balance. He fell about 5 ft., receiving injuries to his back and nervous shock.

An electrician was sandpapering motor slip rings when motor apparently began to heat or burn. The electrician pulled the switch, causing a flash, burning up part of the switch. He received burns about the face, neck, hands and legs, necessitating two weeks confinement in a hospital.

In this case the switch had probably become defective, as it was carrying only about half its marked capacity. Sandpapering of rings should be carefully attended to, using a sandpaper pad with long handle. Never apply emery cloth to the rings, as hot emery is a conductor of electricity.

A quarry shovel helper was moving the mat upon which the shovel travels, when he stepped between caterpillar and mat. As the latter was swung to its forward position he was pinched between the two. Injuries consisted of broken pelvic bone and bruises on the right leg.

Other accidents of the month were of a less serious nature.

State-Owned Cement Plant Losses Cited at Hearing on Government in Business

TESTIMONY regarding loss of taxpayers' money by Michigan's state-operated cement plant near Chelsea, and similar losses in South Dakota, was heard by the Shannon Congressional Committee at South Bend, Ind., recently.

Cement industry leaders, through Porter R. Lynch, director of organization of the Federation of American Business Men, pointed out in a letter that the Michigan plant cost $500,000, while another $200,000 was lost in operation.

The letter also pointed out that last year the legislature ordered it closed and abandoned if not sold by April 1, 1934.

The loss of the South Dakota cement plant was set at $400.000 in operating costs.

How to get Uncle Sam out of business in competition with private business in various lines took up the day.—*Detroit* (Mich.) *Free Press.*

City Bids for Crushed Stone Contracts

THE public works department of Durham, N. C., recently bid on the crushed stone requirements for the new postoffice building and additions to the city sewage disposal plant. In reporting the bid the *Durham Herald* said bids were extremely low in order to win the contracts and hire local unemployed labor. Previously convict labor has been hired to operate the city quarries, but the policy has been modified to give relief to Durham labor.

Nearly 400,000 tons of crushed rock have been sold from the quarry by the public works department since it took over the operation in 1921. It is sold at cost or with a slight margin of profit.

Certainly producers of crushed stone are deeply sympathetic with efforts to aid the unemployed. But it is doubtful that any industry has contributed to a comparable extent when the vast number of competitive quarry operations opened in the name of relief are considered. It is unfortunate that this industry must carry a highly unbalanced load of such competition.

Developing Colorado Bentonite Deposit

BENTONITE mining on a large scale is promised in Gunnison county, Colo., recent tests of deposits found in Lost Canon, 10 mi. north of Gunnison, by Gail and Wallace Moore and Ralph Dennis revealing unusual excellence of the rare clay, says the *Gunnison News-Champion.*

The body of bentonite uncovered is 35 ft. thick and 300 ft. long, with every indication of a huge deposit. Tested by Swift and Co. and by Dr. Schuhmann of the chemistry department of Western State College, it seems to be some of the best clay ever found for refining purposes.

California capitalists have become interested in the property, incorporated by its discoverers as the Colorado Bentonite Co. Intensive development is expected to follow.

RETAIL MATERIAL PRICES, DELIVERED, AUGUST 1, 1932 (COMPILED BY DEPARTMENT OF COMMERCE)

City	Portland cement, per bbl. exclu. of cont.	Gypsum wallboard, ⅜-in., per M	Hydrated lime, per ton	Building sand, per cu. yd.	Crushed stone, ¾-in., per ton	Gypsum plaster, neat, per ton
New Haven, Conn.	$2.40	....	$25.00	$1.25	$2.00	....
New London, Conn.	2.05	$25.00	18.00	1.00	2.00	$18.00
Haverhill, Mass.	2.40	25.00	16.00	......	......	19.00
New Bedford, Mass.	2.40	25.00	16.00	1.25	2.50	16.00
Albany, N. Y.	2.34	23.85	15.75	......	......	16.20
Buffalo, N. Y.	2.95	21.00	18.00	1.85	2.05	16.00
Poughkeepsie, N. Y.	2.00	....	18.00	1.25	2.20	....
Rochester, N. Y.	2.28	22.00	14.50	2.00	2.40	16.00
Syracuse, N. Y.	2.60	20.00	....	1.80	1.50	14.00
Paterson, N. J.	2.00	24.00	18.00	1.50	2.10	17.50
Trenton, N. J.	2.10	28.50	13.25	1.60	1.50	15.50
Philadelphia, Penn.	1.90	....	12.50	1.65	2.40	15.00
Scranton, Penn.	2.40	30.00	18.00	3.38	......	18.00
Baltimore, Md.	2.10	25.00	13.00	1.85	2.50	15.50
Washington, D. C.	2.10	25.00	12.00	......	......	15.00
Richmond, Va.	2.80	38.00	20.00	1.65	2.10	18.00
Fairmont, W. Va.	2.50	35.00	16.00	2.60	3.25	18.00
Columbia, Tenn.	2.45	45.00	12.00	......	2.25	16.00
Tampa, Fla.	2.40	50.00	20.00	2.00	3.50	20.00
New Orleans, La.	2.35	37.20	14.00	2.00	......	18.00
Shreveport, La.	3.00	40.00	16.00	1.50	3.50	20.00
Akron, Ohio	$1.81	$45.00	$14.00	$1.50	$1.55	$15.50
Cleveland, Ohio	1.80	....	12.00	2.03	2.20	18.00
Columbus, Ohio	2.00	....	14.00	1.22	......	16.00
Toledo, Ohio	1.40	20.00	12.00	1.75	2.00	14.00
Detroit, Mich.	2.00	25.00	12.00	2.03	1.75	13.00
Lansing, Mich.	2.25	....	20.00	1.80	1.80	17.50
Saginaw, Mich.	2.00	20.00	16.00	2.50	2.20	17.50
Terre Haute, Ind.	2.20	28.00	18.00	1.25	3.00	18.00
Milwaukee, Wis.	1.88	22.00	14.00	1.25	1.25	15.20
Des Moines, Iowa	2.00	....	....	2.00	......	16.00
Kansas City, Mo.	2.20	25.00	22.00	1.82	1.88	17.00
St. Paul, Minn.	2.10	23.00	19.00	1.25	1.75	17.00
Grand Forks, N. D.	2.60	....	28.00	2.60	......	19.00
Sioux Falls, S. D.	2.00	22.00	20.00	1.25	1.75	15.50
Wichita, Kans.	2.15	25.00	22.50	1.00	......	15.50
San Antonio, Tex.	2.55	39.00	20.00	2.00	2.00	18.15
Tucson, Ariz.	3.29	45.00	29.80	1.25	2.25	17.10
Los Angeles, Calif.	2.30	23.50	24.50	1.00	1.20	15.20
San Francisco, Calif.	2.60	45.00	22.00	1.75	1.75	17.30
Seattle, Wash.	2.70	....	....	......	......	....

New Machinery and Equipment

Aluminum Welding Rod in Coils

THE Linde Air Products Co., New York, N. Y., announces that both the Oxweld No. 14 drawn aluminum rod for welding sheet aluminum and the Oxweld No. 23 aluminum rod for welding cast and sheet aluminum and aluminum alloys are now available in the form of 10-lb. coils of ⅛-in. diameter rod.

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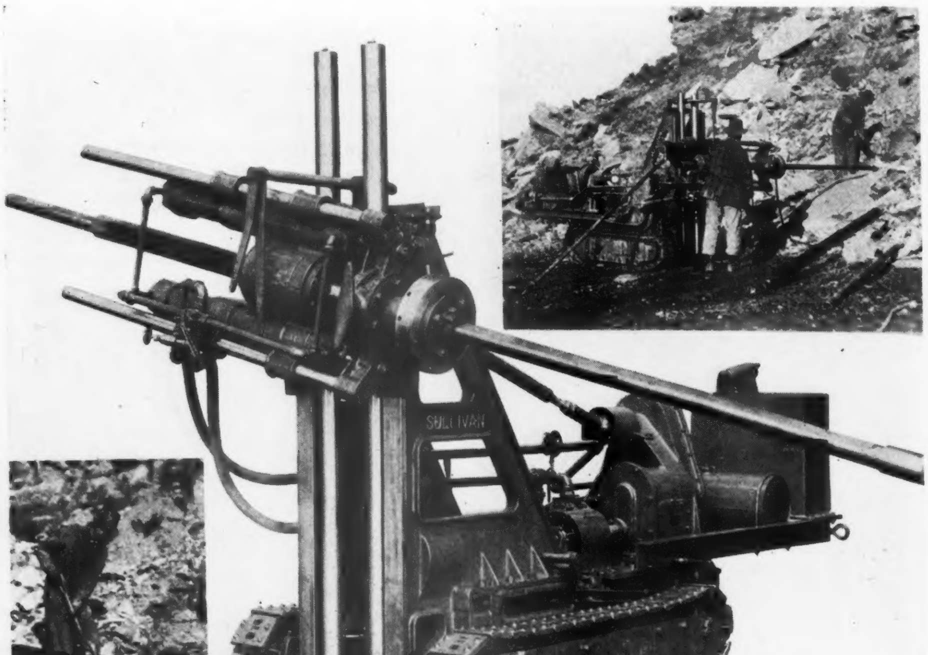
Drill for Open-Pit Blast-Hole Drilling

THE "Stripborer" is announced by the Sullivan Machinery Co., Chicago, Ill., for use in open-pit operations where considerable overburden is to be removed. It is designed to work from the bottom of the pit or from a bench, drilling horizontal holes or holes at any angle to secure the best results.

This new drill consists of a drilling head which rotates the drill steel and bit in the hole. The drive rod is 14 ft. long, with notches every 30 in. The feed is provided with twin oil cylinders which can exert a pressure of 10,000 lb. on the bit, the manufacturer states. Valves regulate the progress of the drill.

Mounting of the drill makes it possible to start the hole from 2 to 6 ft. from the floor, and holes may be drilled at any angle. The entire drilling unit, with power, is mounted on a truck body equipped with crawlers, each crawler having individual control.

According to the manufacturer, drilling cost per yard of overburden has been reduced to less than one-half of previous costs when churn drills were used and explosives were placed in vertical holes.



Drills horizontal holes, or at any angle

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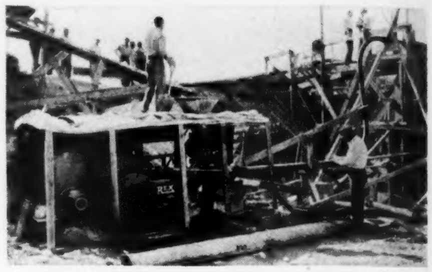
Concrete Pump

THE Chain Belt Co., Milwaukee, Wis., announces a concrete pump, the "Pumpcrete." The first use of this pump in the United States was recently made on a job in Milwaukee. The demonstration lasted 12 hours, during which time the pump handled 125 yd. of mixed concrete to the forms, including 1½ hr. of idle time waiting for delivery of concrete. At one time pumping was resumed after a stop of one-half hour with little effort, the manufacturer states.

The pump is of the piston type, gasoline or electric motor driven, has a capacity of 15 to 20 cu. yd. of concrete per hr., and is portable. It will transport concrete horizontally 500 ft., or up to 72 ft. vertically. In the Milwaukee test 5-in. pipe was used in the pipe line and the pipe used was in 10-ft. sections, equipped with quick couplings.

At left—Discharge from pipe line. Below—Installation of pump on job



American rights have been purchased from a German-Dutch combination which developed and patented it throughout the world.

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Centrifugal Pumping Unit Is Automatically Primed

ANNOUNCEMENT is made by the Worthington Pump and Machinery Co., Harrison, N. J., of a new self-contained automatically primed centrifugal pumping unit.

The new unit comprises an electrically-driven high efficiency ball bearing centrifugal pump, mounted with its motor on a fabricated steel bedplate, together with a "Monobloc" priming unit of the wet vacuum type, controlled by an electric pressure switch. The priming pump, or evacuator, is an adaption of the "Hytor" pump. The evacuator operates to remove air from the centrifugal pump, thereby causing it to be primed.

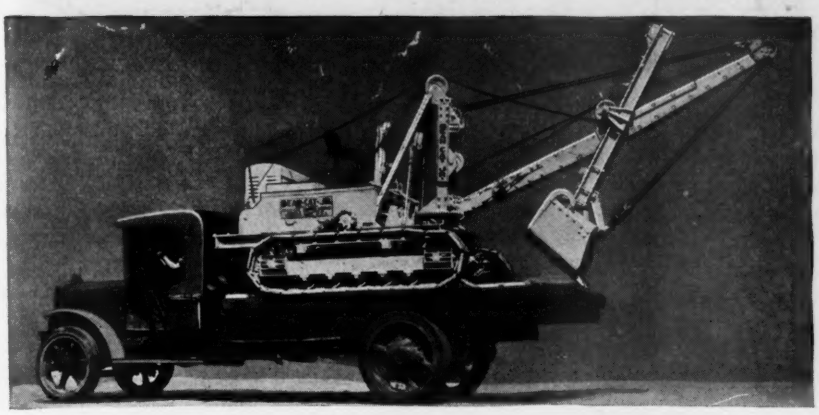
According to the manufacturer, the unit is so designed that efficiency and reliability are maintained with this self-priming feature. Remote control of this unit is practical, it is said.

•

Can Transport Small Shovel On Truck

THE Bear Cat Jr., a new ⅜ yd. convertible shovel, which is light enough to mount and transport on a heavy duty motor truck, is announced by the Bearcat Shovel Works, a division of the Byers Machine Co., Ravenna, Ohio.

The Bear Cat Jr. weighs 6½ tons complete as a shovel. This light total weight is



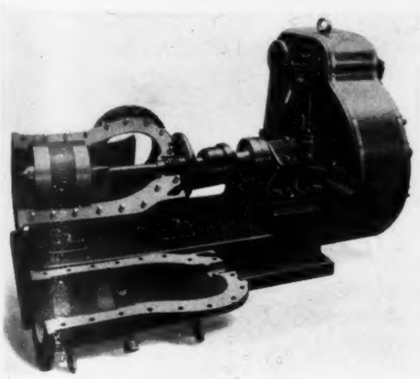
Heavy duty truck provides quick transportation

practical, chiefly because of the balance of machinery which eliminates all dead counterweight, construction which allows all parts to be amply rugged and freedom from crawler mechanism beneath the machinery deck, the manufacturer states.

All operations of traveling, steering from both crawlers, swinging, independent crowding and hoisting are accomplished through three shaft assemblies on the fully enclosed machinery deck. Even the travel shaft is located on the machinery deck; there are no shafts below the main frame. A 3-speed transmission between the motor and take-off gear provides three travel speeds and two operating speeds. The gear driven swinger can be locked to prevent swinging while traveling. All machinery is protected by an automobile type of hood enclosure and motor hood can be locked to prevent theft of gasoline and accessories. Motor is a 4-cylinder slow speed industrial type developing 30 hp.

Propeller Pump

THE De Laval propeller pump announced by the De Laval Steam Turbine Co., Trenton, N. J., which is shown here, is built for both horizontal and vertical installation and is available for all capacities and for heads up to about 40 ft. It may be direct-connected to a standard speed electric motor or steam turbine, or a speed-reducing gear may be used, according to conditions. Its applications include circulating condenser cooling water, lifting storm water, and, in fact, all purposes within the head limitations.



For both vertical and horizontal installation

The pump casing consists of two parts, which are separated in the plane of the center line of the shaft by a flat joint. The pump case cover can be lifted off to render the propeller and all interior parts accessible. The propeller is designed for the specified conditions of capacity, head and speed, and is finished on all surfaces, the blades being filed and scraped to templates. The casing around the propeller is protected by a separate sleeve, which can be renewed should wear occur. This sleeve supports the guide vanes by which the liquid is directed in smooth flow-lines. The shaft is protected from wear by a removable protecting sleeve which extends through the stuffing box and provides a bearing surface for the packing.

At the coupling end the shaft is supported by a grease lubricated ball bearing with a separate ball thrust bearing in the same housing. At the propeller end the shaft is supported by a bearing of the sleeve type. The stuffing box is designed for soft packing, with a lantern ring to facilitate water sealing where desired. The gland is split and can be removed without disturbing the other parts.

Electrode Holder Stand

A NEW ELECTRODE HOLDER stand which automatically shuts down the welder 1 min. after holder is placed on the stand and instantly starts the welder when holder is removed is announced by the Lincoln Electric Co. of Cleveland, Ohio.

It is claimed that the automatic start-and-stop feature of the new stand effects a decided saving in power consumption by shutting the machine down when the operator is not actually welding.

Split Phase Motors

TWO NEW split phase motors are announced by the Wagner Electric Corp., St. Louis, Mo., designated the 44RB and the 56RB. They are redesigned for quiet vibrationless, cool and trouble-free operation, the manufacturer states.

New features of these motors are drip-proof end plates, liberal wool yarn lubrication, conduit box adjustable in four positions and redesigned switch mechanism on the 44RB. They are available in 1/30 to ¼ hp., 1725 and 1140 r.p.m. and in all cycles.

Oil Seal

AN OIL SEAL that is oiltight at the highest operation temperatures and with sudden temperature changes is claimed for the new oil seal announced by the Aetna Ball Bearing Manufacturing Co., Chicago, Ill.

This seal is claimed to be proof against grease, water and other liquids in both vertical and horizontal operation at high and low speeds, to have low static and dynamic loss. It is a self-contained unit.

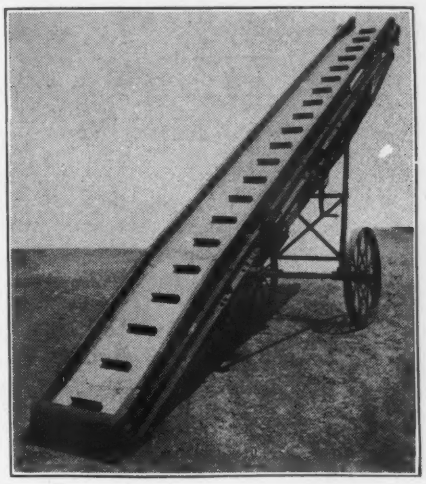
Portable Conveyor

A NEW PORTABLE belt conveyor, embodying numerous improvements over last year's model, is announced by Link-Belt Co., Philadelphia, Penn. Among other features, it incorporates fixed steel retaining sides extending the entire length of the conveyor, thus preventing lumps from spilling over the sides of the belt at any point.

The foot end has been improved to keep material away from the return run of the conveyor belt. Another feature is the arrangement of the foot end plate, permitting the convenient use of the machine without this plate, when desired.

Other features include all-metal troughing idlers with anti-friction roller bearings, bronze-bushed shaft bearings, 9-in. head pulley, ball bearing motor, Alemite lubrication throughout, regulated discharge height through spur geared hand crank, and wide-tread, large-diameter truck wheels fitted with roller bearings.

The machine is suitable for the loading or unloading of any loose material. Various modifications are possible, such as gas engine operation, omission of truck wheels, suspension of conveyor from a trolley, omission of side plates when handling bagged materials, etc.



Sides extend entire length

Starts Operation of New Washed Gravel Plant

THE NEW GRAVEL PLANT of Brewer and Brewer Sons, Inc., Chillicothe, Ohio, is now in operation. A feature of the plant is its crushing and washing equipment, the *Chillicothe News-Advertiser* reports.

This new plant, with additions yet to be made, will represent an investment of approximately $75,000 and is located on the north bank of the Scioto river. It was designed by C. G. Milburn of the Milburn Machinery Co., Columbus, Ohio. W. F. Hopkins, plant superintendent, was also construction superintendent.

A gravel bar in the river, said to be a grade A gravel, supplies the plant. It is worked by a slack line cableway and preliminary investigation indicates that the deposit extends more than 40 ft. deep. A 1½-cu. yd. bucket operates on the slack-line cableway, in a radius of approximately 1000 ft. This bucket dumps the gravel in a stock pile, from which it is taken to the plant by trucks loaded by shovel. Later it is planned to install a rail line to take the place of the trucks. After crushing and washing, the material is screened into eight sizes and stored. There are a number of storage bins now completed and provision is also made for outside storage when requirements may demand it. The plant has a capacity of from 100 to 125 tons per hr.

Replace Stone Claimed Defective

CRUSHED STONE producers in one county in northwestern Ohio are said to be experiencing some difficulties as a result of the abrasion test loss under county specifications for crushed stone. Stone delivered on roads was rejected and the contractor was required to replace it.. It has also been said that the stone was not sufficiently clean, though formal objection on this account was not registered. Most of the stone has been replaced by the contractors involved, the *Fremont Messenger* reports, but it is not as yet determined just who will have to assume the cost of replacement and the loss of the stone originally delivered.

Union Demand Closes Relief Work at Gravel Pit

WORK at the Hiawatha gravel pit near Iron River, Mich., was halted recently as a result of persistent interference from members of the National Miners' union.

The closing order, throwing 170 men out of employment, came after the union had demanded a $3.50 per day wage scale and made other demands of the company. The company was paying the workers about $1.60 a day for work done on a contract basis

The project was in the nature of an unemployment relief measure. — *Milwaukee* (Wis.) *Sentinel*.

Seeks Reduction in Taxes in Supreme Court

CLAIMING that its property on Richmond terrace, New Brighton, N. Y., has been over-assessed by $462,000, the United States Gypsum Co. is seeking a reduction of its assessment through Supreme court action.

A writ of certiorari, granted to the company by Judge Charles C. Lockwood, was filed June 28.

This writ orders the Commissioners of Taxes and Assessments of the city to submit all records pertaining to the assessment of the gypsum plant to the Supreme court. This will be done September 26.

The petition shows that the land and plant of the company are assessed by the city at $1,375,000. The company, on the other hand, claims that the value is only $1,107,500, and should be assessed for less.

The alleged excessive assessments, according to the petition, are in the valuations placed on the improvements on the land.—*Staten Island* (N. Y.) *Advance*.

Publishes Standards for Road Surfacing Materials

THE Federal Specifications Board has recently published the following specifications for road surfacing materials, copies of which may be purchased or borrowed from the American Standards Association: Crushed stone and crushed slag, (for) binder course, sheet-asphalt pavement; crushed stone and crushed slag, (for) bituminous concrete base or surface course; crushed stone and crushed slag, (for) bituminous-macadam base or surface course; crushed stone, crushed slag, and gravel, (for) bituminous-surface treatment; and crushed stone and crushed slag, (for) water-bound base or wearing course.

Gets Local Publicity from Story in Rock Products

FOLLOWING PUBLICATION of the article, "Ingenious Iowa Installation Shows Possibilities of Drag Scraper," in the July 2 issue of ROCK PRODUCTS, describing the operation of the Clear Lake Sand and Gravel Co., the *Clear Lake Reporter* published the story in detail, as it had been published in ROCK PRODUCTS. This is an interesting example of the favorable publicity that may be had by utilizing material that is published in ROCK PRODUCTS.

Resumes Operation of Masonry Cement Plant

THE Century Masonry Cement Co., Rosendale, N. Y., announces that it has resumed manufacturing operations and is now in position to supply Century masonry cement promptly.

Asphalt Paving Conference at New Orleans

NEW ORLEANS has been chosen by the Asphalt Institute for the 10th annual Asphalt Paving Conference to be held either in the week of November 28 or December 5. The program will be devoted largely to phases of low-cost road construction, the major subjects for discussion including (1) The salvaging of pavements which are in need of resurfacing or replacement; (2) serious economic aspects of tax diversion and tax evasion of highway revenues; and (3) the necessity of designing roads in proportion to their importance.

The Association of Asphalt Paving Technologists will, as usual, meet in conjunction with the paving conference.

Elected officers of the Asphalt Institute for the current year comprise: William H. Kershaw of the Texas Co., president; C. W. Bayliss of the Barber Asphalt Co., B. L. Boye of the Standard Oil Co. of New York, and J. A. Blood of the Standard Oil Co. of California, vice-presidents; J. S. Helm of the Standard Oil Co. of New Jersey, chairman of the executive committee; and A. M. Maxwell of the Standard Oil Co. of Ohio, secretary.

The Imperial Oil, Ltd., which withdrew last year, has been reelected to membership in the Institute.

Activity in the Tennessee Phosphate Industry

QUITE an increase has been noted in the number of inquiries from consumers of ground rock for fertilizers. It is not anticipated that the larger operating units will commence operations before October 15, however. This continues to leave operations confined to one plant and to a number of hand mining contractors which are supplying the two large furnace producers of phosphoric acid.

Much interest has been displayed in the recent upward movement in the stocks of the three leading fertilizer companies on the New York Stock Exchange. With the increase in value of cotton and other agricultural commodities, resulting in an increased buying power, prospects for increased demand for these fertilizers become much brighter. This has accounted to some extent for the large increase which has taken place in the quotations for these stocks.

Appoints Receivers for Standard Slag

C. V. WOLFE and Frank Collins were named as receivers for the Standard Slag Co., Youngstown, Ohio, August 30, on application of the Canton Slag Co., the latter asking, in addition, a judgment for $46,089.87, according to the *Canton* (Ohio) *Repository*. The receivership was dissolved September 3, according to the *Cleveland* (Ohio) *Plain Dealer*.

THE INDUSTRY

Incorporations

Hudson Sand and Gravel Co., Batesville, Ark., $5000. Roy Hudson and others.

Maryland Mica Mining Co., 10 Light St., Baltimore, Md. Fred E. Lang.

Lexington Concrete Corp., 122 E. 42nd St., New York City, 200 shares common. A. N. Geller.

Volco Cement Corp., Wilmington, Del., $1,000,000. To produce minerals.

Monarch Sand and Gravel Co., Parma, N. Y., 250 shares common. H. E. MacArthur, Brockport.

Oregon Concrete Pipe Co., Portland, Ore. Albert B. Ridgeway, John C. Kendall and E. A. Johnson.

Port Deposit Granite Corp., Elkton, Md. J. Wesley McAllister of Elkton and Thos. P. Murray, Towson, Md.

Southwestern Development Co., St. Louis, Mo. W. C. Ferguson, 530 N. Union St., St. Louis, and T. P. Bates. Mining.

Buckeye Sand and Supply Co., Bellaire, Ohio, $25,000. David H. Dankworth, David Daneberg, I. Gibbons and Ross Michener, Bridgeport, Ohio.

Lake Erie Sand and Transport Co., Port Clinton, Ohio, $25,000. John Heinsen, Edward Masten, Walter Kolbe and Norton C. Rosenstreter, Oak Harbor, Ohio.

Quarries

Cape Girardeau, Mo. Federal Materials Co. is operating its quarry in South Cape Girardeau on a 24-hour basis.

Independence, Kan. The county is seeking a quarry location and preliminary tests near Coffeyville indicate a suitable deposit has been located. The stone will be used in road construction.

Central Kansas Quarries Co. has opened a new quarry southwest of Garnett, Kan., and has installed two crushers. This material is being used in road projects.

Kentucky Consolidated Stone Co., Louisville, Ky., reports an increase of more than 33% in its business over 1931 since the beginning of its fiscal year. A large portion of this business is said to come from highway construction and railroads.

Louisiana Quarry Co., Inc., Winfield, La., which was leased by its owner to out-of-state interests in December, 1930, has been turned back to the owner, I. L. Lyons, Jr., president of the Southern Mineral Co. It is reported that Mr. Lyons will take over operation of the quarry immediately.

Lee Marble Co., Lee, Mass., is now building a modern marble mill to replace its plant which was destroyed by fire. The design and construction of this plant is in charge of Leo F. Caproni and Co., New Haven, Conn., which has designed and built a number of stone cutting sheds in recent years. Mr. Caproni reports that there is a tendency today towards modernization of cutting sheds because of the gang saws and new carbo machines. These manufacturers are said to be interested in fireproof, well-lighted buildings with heavy and fast crane capacity.

Sand and Gravel

Yant Construction and Gravel Co. has opened a gravel pit at Emmetsburg, Ia.

Appleton, Mo. A gravel pit has been opened on the Gus Johannigmeier place near here.

Adams Construction Co. has opened a gravel pit near Angels Camp, Calif., where it will obtain material for road contracts in that area.

Central Sand and Gravel Co., Memphis, Tenn., is using one of its towboats in transportation of cotton on the Mississippi river.

T. L. Herbert and Sons, Nashville, Tenn., have started operations at the Sangravel plant near Louisville, Ky.

Portsmouth Sand and Gravel Co., Portsmouth, Ohio, has contracted to haul coke for the Wheeling Steel Corp. It will use several of its barges in this work.

Cement

Portland Cement Co. of Utah, Salt Lake City, will start plant and quarry operations August 21.

Lawrence Portland Cement Co. has started operation at its Siegfried, Penn., plant after being idle for about 30 days.

Alpha Portland Cement Co. announces capacity operation started at its Ironton, Ohio, plant September 1.

Universal Atlas Cement Co. expected to start operation of its Independence, Kan., plant September 1.

Canada Cement Co., Ltd., started all departments of its Port Colborne, Ont., plant in operation September 1 after being closed for two months.

Pennsylvania-Dixie Cement Corp. announces plans to resume operations at its Kingsport, Tenn., plant October 1. In the meantime shipments are being made from stock.

Huron Portland Cement Co. placed a temporary distributing plant at Oswego, N. Y., in operation August 20. It is said that a permanent one will be built soon.

Ash Grove Lime and Portland Cement Co. has resumed operation on a partial basis at its Chanute, Kan., plant August 20, following shut down since last February.

Kosmos Portland Cement Co., Louisville, Ky., recently published a 20-page booklet describing Kosmos Super Cement. The booklet has convenient index tabs to facilitate its use.

Cast Stone Construction Co., Bloomington, Ill., has started a fleet of barges in operation on the new 9-ft. channel of the Illinois river. These barges will be used to transport bulk cement for highway construction.

Lime

Lime Products Co., Seattle, Wash., has installed two crushers at its plant to produce agricultural limestone.

Ohio Hydrate and Supply Co., Woodville, Ohio, has established trucking service on agricultural lime and will deliver direct to farms in lots of from 5 to 20 tons.

Silica

Silica Co. of California, Brentwood, Calif., will open a new pit. K. G. Schwegler, manager, says the improvement will cost about $12,000 but will enable the company to obtain sand at a saving of 10 to 15c. a ton.

Cement Products

W. O. Bray, North Wilkesboro, N. C., is opening a new concrete tile plant at Galax, Va., and will manufacture 4-, 6- and 8-in. drain tile and 10- to 30-in. concrete pipe.

Other Rock Products

Growers' Fertilizer Co. announces construction of its new plant at Fort Pierce, Fla. It expected to have the plant in operation September 1.

Edgar Plastic Kaolin Co., Okahumpka, Fla., has resumed operation after having been shut down for more than one year.

Philadelphia Quartz Co., Philadelphia, Penn., described the use of silicate solutions in reclaiming and refining procedures which have for their objective the removal of foreign matter from oils, in a recent issue of *Silicate P's and Q's.*

Personals

Carl L. von dem Bussche, Portsmouth, Ohio, has resigned as secretary and assistant treasurer of the Superior Cement Corp. A successor has not been appointed.

Charles Schmutz, vice-president and sales manager of the Bessemer Limestone and Cement Co., Youngstown, Ohio, has been made president and general manager in place of L. A. Beeghley, who was made chairman of the board.

F. O. Earnshaw, president of the Pennsylvania Stone Producers Association, suffered a painful accident recently. He was thrown from a horse, dislocating his right shoulder and splintering the bones in his right arm.

Blaine S. Smith, president of the Pennsylvania-Dixie Cement Co., recently said "the business outlook is very much better not only in the southeast but in all parts of the country where we do business" during a recent trip to Chattanooga, Tenn.

S. L. Avery, president of the United States Gypsum Co., has been appointed to a committee by President Hoover in his six-point program to stimulate business. The committee on which Mr. Avery will serve will deal with the possibility of repair and improvement of homes.

Dr. E. Lee Heidenreich, consulting engineer, has acquired the business and good will of the Heidenreich Co. (foreign department) and the Heidenreich Engineering Co. and will continue the business of these two companies in the design and construction of liquid and bulk storage facilities, with offices in Kansas City, Mo.

Obituaries

Isaiah White Fuller, 52, president of the Miami Gravel Co. of Cincinnati, Ohio, died August 18 in San Francisco.

Lloyd Elmer Sturm, 72, president of the Sturm and Dillard Co., Columbus, Ohio, died August 26 following an illness of 13 months.

Eugene V. Correll, 40, manager of the Hiddenite Stone and Crush Co., Hiddenite, N. C., died August 27 from a heart attack.

Henry G. Evans, president of the Capital Fertilizer Co., Montgomery, Ala., died September 1 at Roxbury, Mass. Mr. Evans has been active in the phosphate mining industry in the Columbia, Tenn., district for the past 30 years.

Rufus C. Jackson died at his home in Mount Pleasant, Tenn., September 2. Mr. Jackson was a pioneer in the phosphate industry in that district, being associated with his brothers in the Jackson Phosphate Co., which was later merged with the International Agricultural Corp.

Manufacturers

Lombard Iron Works and Supply Co., Augusta, Ga., announces it will build a full line of hydraulic pumps and equipment.

Universal Concrete Pipe Co., New Martinsville, W. Va., announces the removal of its principal office to Columbus, Ohio.

Coppus Engineering Corp., Worcester, Mass., announces the appointment of John B. Foley, Syracuse, N. Y., as its representative in that district.

Rawlplug Co., Inc., New York, N. Y., announces appointment of C. K. Cairns Co., Cincinnati, Ohio, as its representative in that district.

Good Roads Machinery Corp., Kennett Square, Penn., announces it succeeds the Good Roads Machinery Co., Inc.. and that it will continue the manufacture of "Good Roads" products with many new improvements.

Trade Literature

NOTICE—Any publication mentioned under this heading will be sent free unless otherwise noted, to readers, on request to the firm issuing the publication. When writing for any of the items kindly mention ROCK PRODUCTS.

Vibrating Screen. Folder describes the "Whippet," a vibrating screen. ROBINS CONVEYING BELT CO., New York, N. Y.

Shovels. "How to Dig Dirt at Low Cost" describes the Bearcat Jr. ¾-yd. convertible shovel. BEARCAT SHOVEL WORKS, Ravenna, Ohio.

Vibrating Screen. Bulletin 123 describes the "Mitchell" vibrating screen. Test data and information on various applications are given. GIFFORD-WOOD CO., Hudson, N. Y.

Crushers. Folder shows details of construction and illustrates installations of the "Gyro-Centric" crusher. Features are also described. PATTERSON FOUNDRY AND MACHINE CO., East Liverpool, Ohio.

Road Material Testing Equipment. Bulletin 31E describes apparatus for testing asphalt, cement, lime, gypsum, tars, pitches, coal, etc. Illustrations of equipment are also shown. PRECISION SCIENTIFIC CO., Chicago, Ill.

Vibrating Screens. Bulletin 732 describes and illustrates important features of the "Jigger" full floating vibrating screen. Different models are shown. PRODUCTIVE EQUIPMENT CORP., Chicago, Ill.

Small Batch Separator. Folder describes Raymond small batch separator for plant laboratory and small production requirements. RAYMOND BROS. IMPACT PULVERIZER CO., Chicago, Ill.

Enclosed Motors. Bulletin describes the "Whitton" frame-cooled and totally enclosed motors specially designed for quarries and locations having a prevalence of dust and dirt. GENERAL ELECTRIC CO., LTD., London, England.

Bulk Cement Handling Equipment. Loose-leaf catalog illustrates simplified mixing and batching design with reference to the unloading and handling of both cement and aggregates. Methods of unloading railroad cars and barges are shown. FULLER CO., Catasauqua, Penn.

Magnetic Separator. Discussion of separation of iron oxide, garnet, hematite, slate and wolframite from nonmagnetic substances is given. A report of important research of trajectories described by magnetic and nonmagnetic materials from an induced roll is included. DINGS MAGNETIC SEPARATOR CO., Milwaukee, Wis.

Classified Directory of Advertisers in this Issue of Rock Products

For alphabetical index, see page 80

This classified directory of advertisers in this issue is published as an aid to the reader. Every care is taken to make it accurate, but ROCK PRODUCTS assumes no responsibility for errors or omissions. The publishers will appreciate receiving notice of omissions or errors, or suggestions

Acetylene Welding Rod
Haynes Stellite Co.

Aerial Wire Rope Tramways (See Tramways, Aerial Wire Rope)

Agitators, Thickeners and Slurry Mixers
Hardinge Co., Inc
F. L. Smidth & Co.

Air Compressors
Fuller Company
Nordberg Mfg. Co.

Air Filters
Fuller Company

Air Separators
Hardinge Co., Inc.
Kent Mill Co.
Raymond Bros. Impact Pulverizer Co.

Alloys (Metal)
Haynes Stellite Co.

Automatic Weighers
Merrick Scale Mfg. Co.

Babbitt Metal
Jos. T. Ryerson & Son, Inc.

Backfillers
Bucyrus-Erie Company
Ohio Power Shovel Co.

Balls (Grinding)
Lorain Steel Co.

Balls (Tube Mill, etc.)
Allis-Chalmers Mfg. Co.
Lorain Steel Co.
F. L. Smidth & Co.

Bearings
Chain Belt Co.
Haynes Stellite Co.
Link-Belt Co.

Belt Fasteners (Steel)
Flexible Steel Lacing Co.

Belt Lacing (Steel)
Flexible Steel Lacing Co.

Bin Gates
Chain Belt Co.
Fuller Company
Link-Belt Co.

Blocks (Pillow, Roller Bearing)
Link-Belt Co.

Boilers
Combustion Engineering Corp.

Breakers (Primary)
Smith Engineering Works

Buckets (Dragline and Slackline)
Bucyrus-Erie Co.
Wellman Engineering Co. (G. H. Williams)

Buckets (Dredging and Excavating)
Wellman Engineering Co. (G. H. Williams)

Buckets (Elevator and Conveyor)
Chain Belt Co.
Hendrick Mfg. Co.
Link-Belt Co.

Buckets (Grab, Clamshell, etc.
Link-Belt Co.
Wellman Engineering Co. (G. H. Williams)

Cableways
General Electric Co.
Link-Belt Co.
Macwhyte Co.
Wellman Engineering Co. (G. H. Williams)
Williamsport Wire Rope Co.

Cap Crimpers and Fuse Cutters
Ensign-Bickford Co.

Car Pullers
Link-Belt Co.

Cars (Dump)
Lorain Steel Co.

Cars (Quarry and Gravel Pit)
Atlas Car & Mfg. Co.
Easton Car & Construction Co.
Lorain Steel Co.

Castings
Haynes Stellite Co.
Link-Belt Co.

Cement Making Machinery
F. L. Smidth & Co.

Cement Pumps
Fuller Company
F. L. Smidth & Co.

Central Mixing Plants (Concrete)
Chain Belt Co.

Chain (Dredge and Steam Shovel)
Bucyrus-Erie Co.

Chain (Elevating and Conveying)
Chain Belt Co.
Link-Belt Co.

Chain Drives
Chain Belt Co.

Chain Systems (Kiln)
F. L. Smidth & Co.

Classifiers
Link-Belt Co.

Clips (Wire Rope)
Macwhyte Co.
Williamsport Wire Rope Co.

Coal Pulverizing Equipment
Hardinge Co., Inc.
Raymond Bros. Impact Pulverizer Co.
F. L. Smidth & Co.

Compressors (See Air Compressors)

Conveyor Idlers and Rolls
Chain Belt Co.
Link-Belt Co.

Conveyors and Elevators
Chain Belt Co.
Fuller Co.
Lewistown Fdy. & Mach. Co.
Link-Belt Co.
F. L. Smidth & Co.
Smith Engineering Works

Conveyors (Pneumatic)
Fuller Company

Conveyors (Screw)
Link-Belt Co.

Coolers (See Kilns and Coolers, Rotary)

Correcting Basins
F. L. Smidth & Co.

Couplings (Flexible and Shaft)
Chain Belt Co.
Link-Belt Co.

Cranes (Clamshell)
Bucyrus-Erie Co.

Cranes (Crawler and Locomotive)
Atlas Car &Mfg. Co.
Bucyrus-Erie Co.
Link-Belt Co.
Ohio Power Shovel Co.
The Osgood Co.

Crushers (Hammer)
Lorain Steel Co.

Crushers (Jaw and Gyratory)
Allis-Chalmers Mfg. Co.
Lewistown Fdry. & Mach. Co.
Nordberg Mfg. Co.
Smith Engineering Works

Crushers (Single Roll)
Link-Belt Co.
McLanahan & Stone Corp.

Crushing Rolls
Allis-Chalmers Mfg. Co.

Derricks and Derrick Fittings
Wellman Engineering Co. (G. H. Williams)

Dippers and Teeth (Steam Shovel)
Bucyrus-Erie Co.

Dipper Teeth
The Frog, Switch & Mfg. Co.

Ditchers
Bucyrus-Erie Co.

Draglines
Bucyrus-Erie Co.
Link-Belt Co.

Dragline Cableway Excavators
Bucyrus-Erie Co.
Link-Belt Co.

Dragline Excavators
Bucyrus-Erie Co.
Ohio Power Shovel Co.
The Osgood Co.

Dragline Excavators (Walking)
Bucyrus-Monighan Co.

Dredge Chain (See Chain)

Dredges
Bucyrus-Erie Co.
Morris Machine Works
The Osgood Co.

Drives (See Gears, Chain Drives, etc.)

Drives (Short Center)
Allis-Chalmers Mfg. Co.

Dryers
Allis-Chalmers Mfg. Co.
Combustion Engineering Corp.
Ruggles-Coles Div. of Hardinge Co., Inc.

Dust Collecting Systems
Allis-Chalmers Mfg. Co.

Dust Conveying Systems
Fuller Co.

Electric Mine Hoists
Nordberg Mfg. Co.

Electric Power Equipment
Allis-Chalmers Mfg. Co.
General Electric Co.

Elevators (See Conveyors and Elevators)

Engineers
F. L. Smidth & Co.
R. D. Wood & Co.

Engines (Diesel)
Nordberg Mfg. Co.

Engines (Steam)
Morris Machine Works

Excavating Machinery (See Shovels, Cranes, Buckets, etc.)

Fans
General Electric Co.

Feeders
Chain Belt Co.
Fuller Co. (Cement and Pulverized Material)
Smith Engineering Works (Plate)

Filters and Strainers (Gasoline)
Alemite Corp.

Frogs and Switches
Atlas Car & Mfg. Co.

Furnaces
Combustion Engineering Corp.

Fuses (Detonating and Safety)
Ensign-Bickford Co.

Fuses (Electrical)
General Electric Co.

Gas Producers
R. D. Wood & Co.

Gates (Bin) (See Bin Gates)

Gears and Pinions
Chain Belt Co.
General Electric Co.
Link-Belt Co.

Grapples (Stone)
Wellman Engineering Co. (G. H. Williams)

Grease
Alemite Corp.

Grizzlies
Smith Engineering Works

Hammer Mills (See Crushers)

Hard Facing Materials
Haynes Stellite Co.

Hascrome
Haynes Stellite Co.

Hastelloy
Haynes Stellite Co.

Hoists
Link-Belt Co.

Insulation (Electric)
General Electric Co.

Kilns and Coolers (Rotary)
Allis-Chalmers Mfg. Co.
Hardinge Co., Inc.
F. L. Smidth & Co.

Kominuters (See Mills)

Lamp Guards
Flexible Steel Lacing Co.

Lighters—Hot Wire (For Safety Fuse)
Ensign-Bickford Co.

Lime Handling Equipment
Fuller Co.
Link-Belt Co.
Raymond Bros. Impact Pulverizer Co.

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Contents for September 24, 1932

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